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Some Bridges on the Columbia Highway

By K. P. Billner*

The Columbia Highway, now being constructed, follows the south bank of the Columbia River from Biggs, Ore., through Portland, to Astoria.

The magnificent scenery along the route, particularly between Portland and Hood River, is unsurpassed in this country. Along this portion of the highway are numerous mountain streams and ravines which had to be spanned, and the writer was asked to work out the designs for the bridges. In this work it has been his aim to build structures which would harmonize with the mighty surroundings and at the same time give the factors of safety and low cost their due consideration. No standard types were adopted, but reinforced - concrete structures had the preference over steel bridges.

Below are given descriptions of some of the most noteworthy of the structures.

Latourelle Bridge

The bridge at Latourelle (Figs. 2-3) is an original type by the writer, although its principles are borrowed from the French expert, the late M. Considère. The principal characteristic of this bridge is its lightness. It is 312 ft. long and 97 ft. high to grade of the roadway. It has a 17-ft. driveway and the total width, including two cantilever sidewalks and railings, is 25 ft. The concrete above ground amounts to only 560 cu.yd., making presumably the lightest concrete bridge, relative to its dimensions, in this country. It was desired to erect a light structure for several reasons, among which the difficulty in securing a firm foundation was foremost. The underlying bedrock is covered with a layer of silt and boulders to an average depth of 25 ft. on the western bank, while on the east side of the creek is a deposit of drift sand, 50 ft. in depth. The cost of building abutments and piers for a heavy type of bridge would have been very high with these conditions of the foundation to contend with.

Fig. 1. Footbridge over Lower Multnomah Falls, on the Columbia Highway, Oregon
(Length of span, 45 ft.; height above creek, 105 ft.; erected September, 1914.)

Substructure—The abutments, as well as the piers, were founded on bedrock. The west abutment and the two central column bents were placed directly on bedrock. The east abutment was put on four columns, two 4 ft. square and two 5 ft. square. The average depth of these

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columns is 45 ft. from the under side of the abutment to the rock. The tops of the 5-ft. columns are connected to the bottoms of the 4-ft. columns by inclined struts, which transmit the thrust from the arches down to the rock foundation.

SUPERSTRUCTURE—Each end of the bridge consists of two girders, which carry a set of columns and struts on which the roadway is erected. This makes a cantilever effect, but the cantilever action which might develop was not considered in the calculations of the stresses in the structure. The central portion of the bridge consists of three 80-ft. arch spans. Two arch ribs carry each span. These ribs are 20 in. square and are reinforced by eight longitudinal 1-in. square bars and No. 0000 hooping of 18-in. diameter and 2-in. pitch. The arches are parabolic in shape. The deck load and any superimposed load are carried to the arch rings on vertical columns placed at 10-ft. centers.

To insure against bending moments in the arch ribs from partial loading, diagonal members are erected between the junction points of the arch ribs and the vertical columns and the deck and the columns. These diagonal members are subjected to alternatingly compressive and tensile stresses, and therefore special care had to be employed in the construction of the junction points. The reinforcing bars of the diagonals are hooked around the longitudinal reinforcement of the arch ribs and also around the longitudinal reinforcement of the girders, which form the edges of the deck. Where it was found impossible to hook the bars to one another as described, special dowels were inserted in the hooks. The joints received a particularly rigid inspection during the erection of the bridge. The balustrades are made of artificial stone.

OUTLINE OF CALCULATIONS—Permissible stresses in the materials were assumed as follows: Concrete in bending, 600 lb. per sq.in. compression; concrete in direct compression, 500 lb. per sq.in.; hooped concrete in the arch ribs, 750 lb. per sq.in.; steel in tension, 16,000 lb. per sq.in.; steel in shearing, 10,000 lb. per sq.in.

LOADING—A uniform load of 100 lb. per sq.ft., a concentrated load of 15 tons, and an impact factor of 25% were adopted.

The analysis was made for three conditions of loading: First, A uniform load over the entire bridge; second, half the span of one arch loaded; third, two spans were fully loaded, with no load on the third span.

The springing points of the arches were restrained from moving by making the main columns act as beams with double reinforcements.

CONSTRUCTION—The falsework was erected with a tower at each end of the bridge, and a cableway. All of the forms were built and braced before the concreting of the superstructure commenced. The main columns, which are about 90 ft. high, were poured in sections which were allowed to set for a few hours before the next pouring commenced. The arch ribs were poured simultaneously, commencing at the springings and working toward the crowns. The deck, containing 250 cu.yd. of concrete, was poured in a continuous operation lasting 20 hours. The maximum settlement during the pouring of the arches was 3/8 in. The deck was poured after the arches had set for 12 days. No settlement took place while the deck was being poured or after. The centers were struck six weeks after the pouring of the arches.

FIG. 2. BRIDGE AT LATOURELLE ON THE COLUMBIA HIGHWAY

The principal advantage of this type of a bridge is the small amount of concrete required. The added expense of formwork is more than paid for by the saving in materials. The bridge makes a very pleasing appearance.

The contractor for the bridge was Geo. Battersby, of Portland; Messrs. Montague and Johnson had a subcontract for the fabricating and placing of the steel. Credit is due them for the very satisfactory workmanship and for the faultlessly finished structure.

BRIDGE AT SHEPHERDS DELL

This bridge (Figs. 4-6) is of a standard type, but has one original feature in the reinforcing of the spandrels.

The spandrels are reinforced in such a way as to make them act as girders, and are capable of sustaining the bending moment from the live load over half the span. These spandrels, therefore, will distribute the loading on the arches. The influence of the stiffening of the spandrels, although of great value, has not been considered in the determination of the dimensions of the arch ribs. The clear spans in the Shepherds Dell bridge are each 100 ft.

Viaducts

Among problems which arose in the construction of the Columbia Highway were two which necessitated the building of viaducts. A glance at Figs. 7 and 9 will be sufficient to explain the situation. The Highway at these places is located on a steep mountainside, at the foot of which the Oregon-Washington R.R. & Navigation Co.'s line is located. To excavate a 24-ft. roadway out of the hillside would have meant the moving of an enormous quantity of earth with no place to dump it. In order to avoid this, the viaducts were erected.

Fig. 8 shows a cross-section of the viaduct at Multnomah Falls and is typical of the design of these "side-hill" viaducts. Essentially the construction is a solid reinforced-concrete slab, crowned to the road crown, which rests on transverse floor-beams spanning between columns on the low side and a continuous girder on the high side. These columns are spaced every 20 ft. and foot on prismatic bases. The up-hill girder rests on square concrete plates and the plates and column footings are tied together by reinforced-concrete struts taking the slope and embedded in ground. Longitudinal stiffness is also given by girders at the top of the columns under the railing.

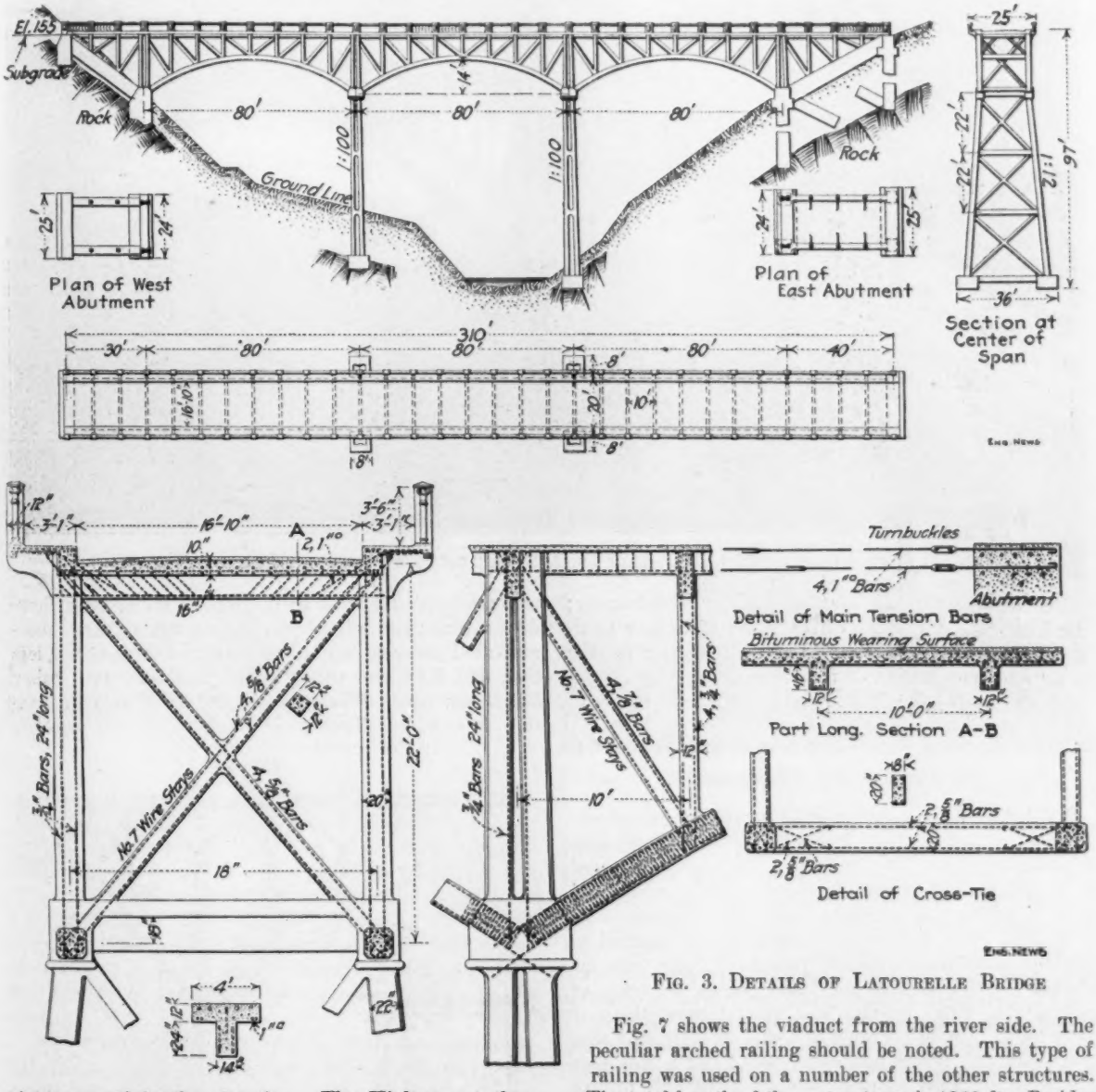


Fig. 3. Details of Latourelle Bridge

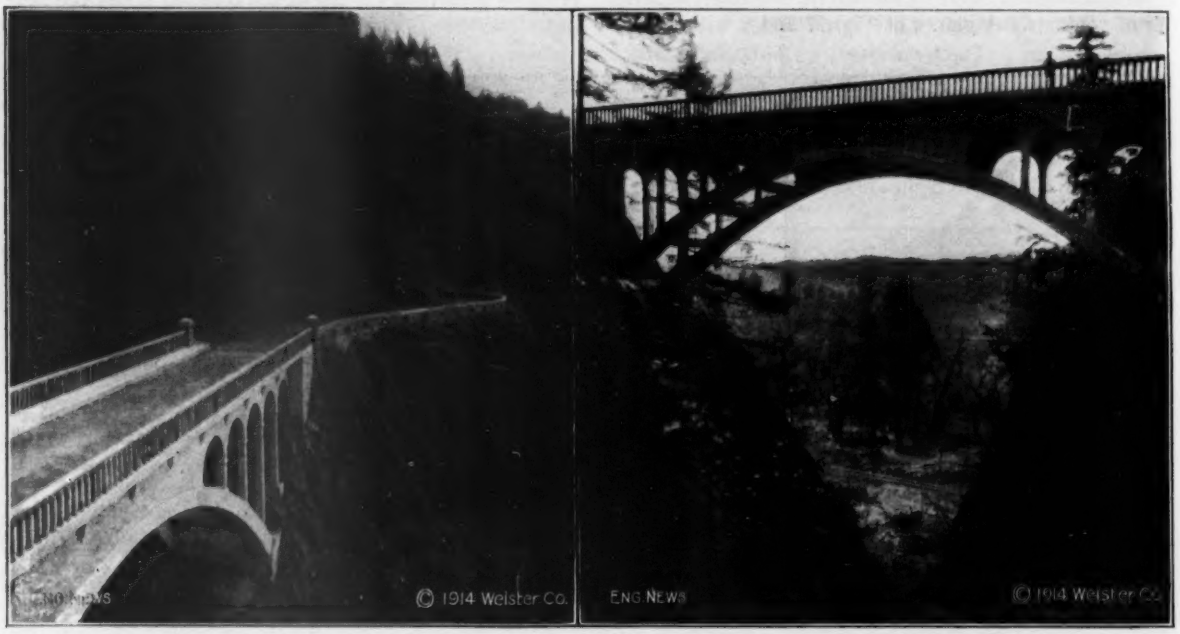
Fig. 7 shows the viaduct from the river side. The peculiar arched railing should be noted. This type of railing was used on a number of the other structures.

The total length of these structures is 1260 ft. Besides eight concrete bridges erected on the Highway, there is to be mentioned a footbridge over the lower Multnomah Falls 105 ft. in the air. This bridge, shown in the first-page view, was donated by S. Benson, of Portland, Ore. The total length of roadway of these bridges and viaducts is 2012 ft. The contract price was only $76,500.

The price per square foot of deck surface varies from $1.25 for the viaducts to $3 for the high bridges. The eight structures east of Latourelle were erected by the Pacific Bridge Co., of Portland. All of the structures are well erected and show no imperfections.

PERSONNEL

The Columbia Highway in Multnomah County is being constructed by S. C. Lancaster, Assistant State Highway Engineer, Consulting Engineer for Multnomah County; H. L. Bowlby, State Highway Engineer; J. B. Yeon, Roadmaster; A. S. Benson, Assistant Roadmaster; Rufus Holman, Chairman of the Board of County Commissioners. The writer was appointed engineer for the design and construction of the bridges.



FIGS. 4-5. TWO VIEWS OF THE SHEPHERDS DELL BRIDGE ON THE COLUMBIA HIGHWAY, OREGON

Standards for Gas and Electric Service in Illinois

Standards for gas and electric service were recently adopted by the Illinois Public Utilities Commission, becoming effective Nov. 1, 1914. They were prepared by S. B. Farwell, Chief of Service Department, and A. F. B. Little, Gas Engineer, under the direction of R. F. Feustel, Chief Engineer. Companies are required to keep for three years complete records of their tests for adequate service, complaints, interruptions, accuracy of meters, etc., with monthly and annual tabulations of meter tests. Any meter must be tested on complaint once in six months. Where meters are found fast a consumer is to have refunded a proper percentage of bills for six months previous; where meters are slow a bill may be rendered to the consumer for the full consumption during the six months preceding, if the company is not negligent.

For gas utilities, the cubic foot in tests is defined as at 60° F. and 30 in. of mercury, when saturated with water vapor; for measurement to a consumer, the cubic foot of gas is defined as volume under existing conditions but at a temperature not over 75° F. Meter provers must determine the accuracy of meters within ½%. When installed, meters must be out not over 1% in passing gas at 6 cu.ft. per hr. per rated light capacity. Meters must be tested at least once in five years. If a meter is accurate within 2%, no adjustment of bills is involved. The commission will test meters at fees ranging from $2 to $8, depending on capacity. A company with output exceeding 20,000,000 cu.ft. per year must have a complete standard calorimeter outfit, and the heating value of manufactured gas must be determined on at least three days a week; for natural gas, three times a year. Manufactured gas must have a total calorific value of not less than 565 B.t.u. per cu.ft., and it must not drop below 530 at any time. Where the gas is carried at 5-lb. pressure or over, an allowance of 35 B.t.u. in the monthly

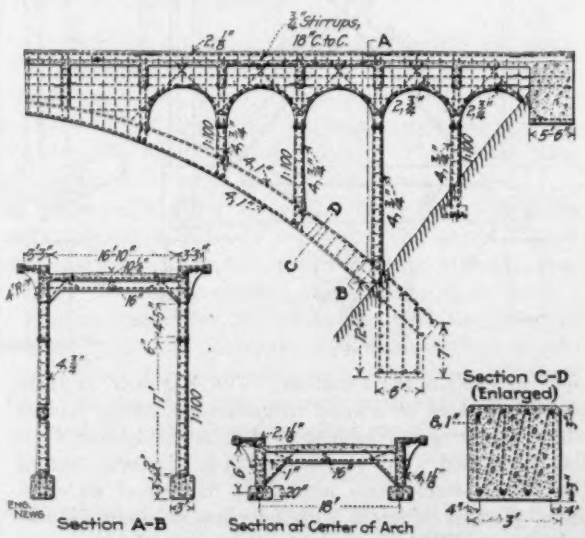


FIG. 6. DETAILS OF THE SHEPHERDS DELL BRIDGE

FIG. 7. SIDE-HILL VIADUCT AT MULTNOMAH FALLS, 860 FT. LONG

average is made and the minimum value is placed at 520 B.t.u. Sulphur content is limited to 30 grains per 100 cu.ft.; hydrogen sulphide to 1 grain. Outlet pressure must not be less than 2 or more than 8 in., except under special contract. Daily variation of pressure at any outlet must not be greater than 100% of the minimum. Each company must have one or more portable graphic record-

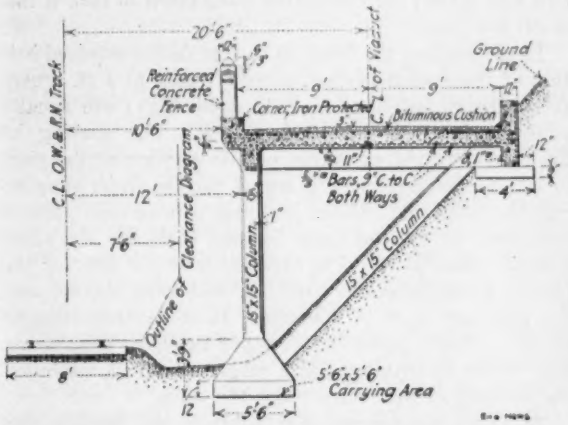


FIG. 8. SECTION OF MULTNOMAH FALLS VIADUCT

ing pressure gages and must make frequent pressure surveys. Companies must make street-main extensions free of charge, provided the length of the entire extension is not greater than that obtained by allowing 100 ft. per consumer for a low-pressure system and 200 ft. per consumer for a high-pressure system. Extensions above the free limit must be made if proper compensation is offered.

Electricity-supply companies are required to have working meter standards, accurate within ½%, and check standards. In testing a meter, two determinations agreeing within ½% must be made at 10% and at 75%, rated capacity or full connected load. The average error, of these two values, of a meter at installation must be not over 2%. A meter in service may have an error of not more than 4% before adjustment of bills is necessary. The commission will test watt-hour meters at figures ranging from 82 upward. The voltage variation on constant-potential lighting systems must not exceed 5% of the adopted standard voltage; for power circuits the variation may reach 10%. Voltage surveys and records must be made by the company. Sustained variations of frequency on alternating-current systems must be not over 5% of a fixed standard.

Station records must show time of starting and stopping generating apparatus; starting and disconnecting

FIG. 9. MULTNOMAH FALLS VIADUCT UNDER CONSTRUCTION

street-lighting circuits; reading of instruments necessary to determine character of load; all interruptions to service, with time, duration, extent and cause. An interruption is defined as the interval during which voltage falls below 50% normal. Grounding of all secondaries of alternating-current circuits is required in all new construction and according to the rules of the National Electrical Code. Free extensions of service must be made, provided any such line requires no more than twice as many poles at standard spacing as there are individual applicants. Extensions above the free limit must be made if proper compensation is offered.

British Locomotive Exports—In spite of war, shipments for nine months ending Sept. 30 had a value of $14,648,000, compared with $10,337,000 and $7,155,000 for similar periods in 1913 and 1912 respectively. The locomotives went mostly to India, Australia, Argentina and South Africa.—London "Engineering."

New York Rapid Transit Railway Extensions*

By F. Lavis†

IX--Underpinning Buildings along the Line

Under the general heading of "protection of adjacent buildings" the specifications provide for three classes of work.

A. Buildings "which are supported on firm soils" and bearing such a relative position in regard to the subway structure that a slope "represented by 1 ft. vertical to 2 ft. horizontal, inclined downward from the bottom outer edge of the building foundation, passes beneath the bottom outer edge of the completed subway structure" have to be taken care of by the contractor, and such cost as there may be is included in the price for *excavation*.

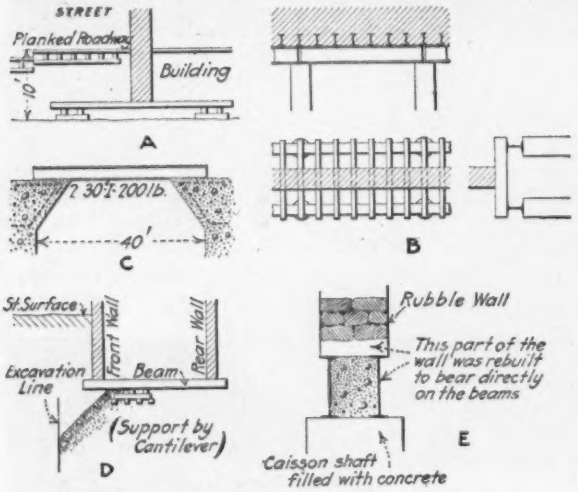


FIG. 53. SKETCHES ILLUSTRATING VARIOUS TYPICAL METHODS OF UNDERPINNING BUILDINGS

A—Underpinning by needles, ordinary form.
B—Underpinning by pile and short cross I-beams.
C—Underpinning by piers and I-beam between.
D—Underpinning by cantilever.
E—Underpinning by caisson and I-beams.

B. When necessary to secure adjacent buildings or to prevent bringing an unusual pressure on the subway structure when completed, the contractors are required to "safely and permanently underpin adjacent buildings the foundations of which are above the bottom of the adjacent subway excavation." This work is paid for at a price bid per front foot of the building. The latter are classified according to height, less than seven stories, seven to twelve stories, and over twelve stories. The prices for this work on contracts let so far range from $50 to $100 per front foot for 7-story buildings and from $75 to $200 with an average of about $150 for buildings 7 to 12 stories. The prices are, however, very irregular and there is little distinction in the bidding between uptown and downtown. Bids for underpinning buildings over 12 stories range from $90 to $400 per front foot and are too few and erratic to be of any use as a guide to the cost of the work.

C. In certain cases where underpinning is not considered necessary but where buildings have to be secured and maintained during construction, there is a price bid per front foot for "maintaining, protecting and securing." These prices range from $15 to $60 and average about $40.

It is generally required that underpinning be carried down to solid rock or to at least 2 ft. below the lowest excavation for the subway, if rock is not encountered before that depth is reached.

Often when the necessary excavation for the subway structure takes a fairly large proportion of the width of the street, the excavation of the "first lift" is carried out to the full width of the street between building lines and to the depth of the cellar, thus providing easy access for working as is shown in Fig. 53A. The excavation of this first 10 ft. is generally first carried ahead the whole length of the section, or for a considerable portion of it, and this is followed by the underpinning before any further excavation is undertaken.

Probably the most common way of supporting ordinary buildings is to temporarily carry the walls to be supported on needles, generally I-beams, as shown in Fig. 53A and extend the foundation walls down to rock if this is not too deep.

In cases where the depth to rock or to the required bottom of foundation is deep, piers (from 2 to 3 ft. square for ordinary buildings 5 or 6 stories high) are usually sunk at intervals of 10 to 15 ft. The spacing of the piers depends, of course, on the position of the piers or columns of the building which require direct support, and the front wall of the building between the piers is supported on two or more I-beams spanning the space between these piers. The excavation of the pits for the piers is usually made by hand, the well being sheeted, and the piers are built of concrete. In some cases, instead of the concrete piers, 12-in. pipes in short lengths are sunk either by driving with a weight or with a water jet, the subsequent procedure being the same.

To avoid supporting the buildings on needles, two methods have been used, somewhat similar in principle. Concrete piers 2 ft. square are sunk to rock in pairs, one inside and one outside the wall, each pair 10 to 12 ft. apart, or instead of the piers, 12-in. wrought-iron pipes in lengths of about 4 ft. with inside sleeve couplings are sunk and filled with concrete, the tops of these piers or pipes being 20 to 30 in. below the cellar floor. I-beams of suitable size (50 to 60 lb. generally for ordinary buildings) are then laid on top of these piers or pipes parallel and adjacent to the walls of the buildings; small holes are then broken through the wall and smaller I-beams put through spanning the first two and the walls caught up on these, as shown in the sketch in Fig. 53B.

On one section where a building of moderate size had to be taken care of, piers were sunk to rock (or to the required depth) and then the wells were widened out at the top in the direction of the line of the building, as shown in Fig. 53C, and filled with concrete, in which reinforcing rods were placed. These piers were 30 to 40

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ft. apart and the space between them was spanned by two 30-in., 200-lb. Bethlehem beams, which were placed in niches cut in the wall to receive them.

On Section 14, Lexington Ave., W. Melvin, Superintendent for the McMullen & Hoff Co., devised a form of

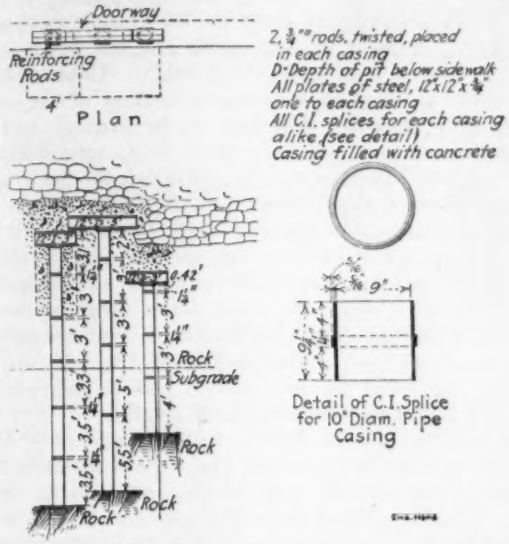
Doorway
Reinforcing Rods
Plan
2, ¾"ø rods, twisted, placed in each casing
D-Depth of pit below sidewalk
All plates of steel, 12"x12"x⅜"
one to each casing
All C.I. splices for each casing alike (see detail)
Casing filled with concrete
Rock Subgrade
Rock
Rock
Detail of C.I. Splice for 10" Diam. Pipe Casing

FIG. 54. UNDERPINNING BUILDINGS WITH STEEL-PIPE PILES FILLED WITH CONCRETE

shield on the principle of the tunnel shield, but reduced to its simplest elements, to sink 3-ft. 6-in. cylinders vertically for underpinning. The apparatus is shown by the drawings, Fig. 55, and, as will be seen, consists simply of a cylinder of ¼-in. boiler iron about 3 ft. long with a 3x4-in. angle bent to circular form to fit inside just back from the lower end. Four segments, as shown in the drawing, form an 18-in. ring, which is added to the bottom of the caisson inside the tail of the shield as this latter is shoved down. The shield is "shoved" by four jack bolts, bearing against the 3x4-in. angle of the shield and reacting against the last ring.

The material is removed by means of small buckets which are raised by a hand winch and taken out of the top through the air lock. On account of the small working compartment only one man can work at the excavation, but usually there is another puddling the joints and sealing the shaft.

The shield, of course, was left in the bottom when the caisson was concreted. These caissons were sunk about 20 to 25 ft. apart, directly under the front walls of the buildings, the location depending on the location of the main columns or piers which it was desirable to support directly. The space between them was spanned by two 26-in., 150-lb. Bethlehem beams on which the wall was supported directly, as shown in Fig. 53E.

At one point on Section 13, Lexington Ave., where the rock was quite near the surface and the necessary excavation close to the building line, a slip occurred in the rock, endangering the front of the building. In order to avoid blocking up in the excavation, long I-beams were used as cantilevers, blocked up in the cellar just back of the front wall and running back under the back wall, against which they were blocked and which afforded the necessary reaction, as shown in the sketch in Fig. 53D.

On Sections 8, 9, 10 and 11, Lexington Ave., three methods were used: *First,* the common one of supporting the buildings on needles while the walls were carried down in trenches to rock, this being usually adopted when the rock was not deep. *Second,* piers of concrete about 5 to 6 ft. wide and 8 to 10 ft. long were sunk to rock or subgrade and spanned by two or sometimes three I-beams on which the building wall was carried. This method was usually used where the rock or subgrade was deep, say 10 ft. or more below the basement floor of the building. *Third,* 10-in. iron pipes in lengths of 3 to 5 ft. with inside sleeve couplings were sunk under the walls and capped with I-beams, as shown in Fig. 54. The pipes were forced down by jackscrews reacting against the walls of the building, and were put down under columns or sections of the wall which carried the load. They were sunk dry and the material inside excavated with small orange-peel scoops. The small boulders encountered were taken out by a sort of net on the end of a pole called a "snare." They were supposed to be sunk to rock, sealed to it by a rich cement mortar, and filled with concrete in which were embedded two ¾-in. square steel rods.

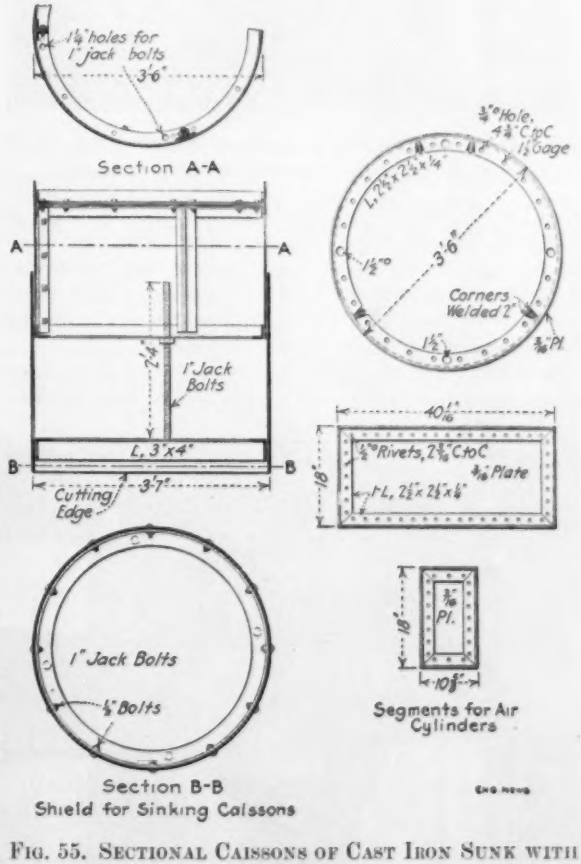

FIG. 55. SECTIONAL CAISSONS OF CAST IRON SUNK WITH SHIELD

This method of underpinning is quite effective and safe in many cases and, of course, is very much cheaper than either of the first two methods, if the foundations have to be carried down to any great depth. The defects are that it is sometimes difficult to tell if the pipes are on solid rock or on a boulder, and if the excavation for the subway or other purpose comes close to the building line, the front of the pipes may be uncovered, leaving

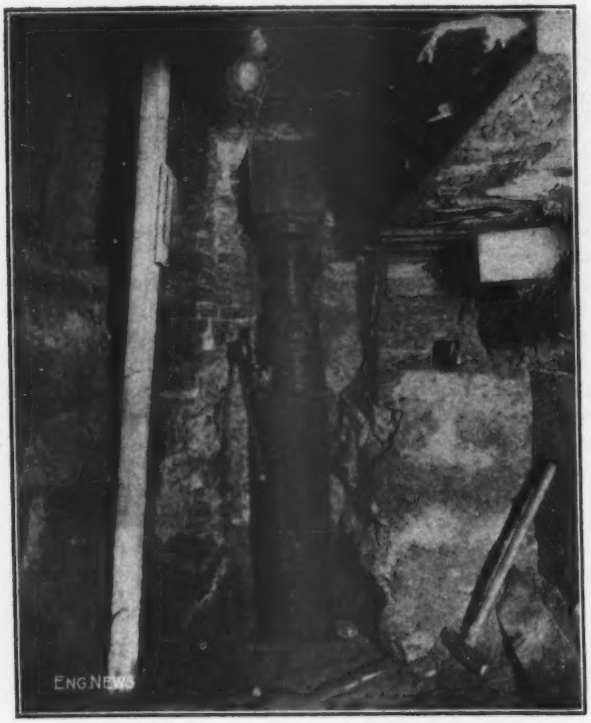

FIG. 56. PUTTING DOWN HOLLOW STEEL PILE WITH HYDRAULIC JACK REACTING AGAINST BUILDING

them as practically unsupported columns. So far as could be learned, however, where they have been used so far, they have served their purpose and no actual difficulty or failure has been encountered. This work was done by the Underpinning & Foundation Co., under a subcontract from the principal contractors.

A method which obviates the necessity of supporting the buildings on needles was developed and used on Sections 1 and 3 of the Broadway line. It consists essentially in tying the foundation columns together with a reinforced-concrete mattress or girder, as shown in Fig. 59, then sinking pits or piles under it to the required depth. Built-up steel girders or I-beams are first laid along on either side of the columns and parallel to the face of the building, at about the level of the basement floor, or just below it, one outside and one inside and tied to each column and to each other. These girders are made up of short sections, on account of the confined space in which they have to be handled, and a convenient form is one made up of four angles latticed together, and riveted so as to be continuous for the length of the front of the building (see Fig. 58), though I-beams are used in some cases. Light hitches are cut in the piers to get a firm bearing, and the girders or I-beams are tied together firmly with rods or sometimes with steel-wire ropes, the whole being then concreted, making a continuous reinforced-concrete girder supporting the whole front. The photograph, Fig. 58, shows in the foreground the two latticed girders and behind that the completely concreted beam or girder.

Rectangular pits are then sunk at intervals under this girder, as shown in the sketch, Fig. 59, and in spaces between the column footings so that the ground under these latter remains undisturbed. The pits are sheeted with horizontal sheeting, and are sunk to the necessary depth, i.e., to 2 to 3 ft. below the subgrade of the subway structure, and filled with concrete. Care is taken not to have the open pits close together. About two at a time, some distance apart, are put down, filled and blocked under the concrete girder before others are started. If water is encountered, hollow steel piles in short sections are sunk from the bottom of the pits below the water level and filled with concrete. All piles are tested by hydraulic pressure to take up any slight settlement.

There are two methods of sinking these hollow steel piles which are quite extensively used, one by the use of

FIG. 57. UNDERPINNING WITH NEEDLES BUILDING AT 459 BROADWAY

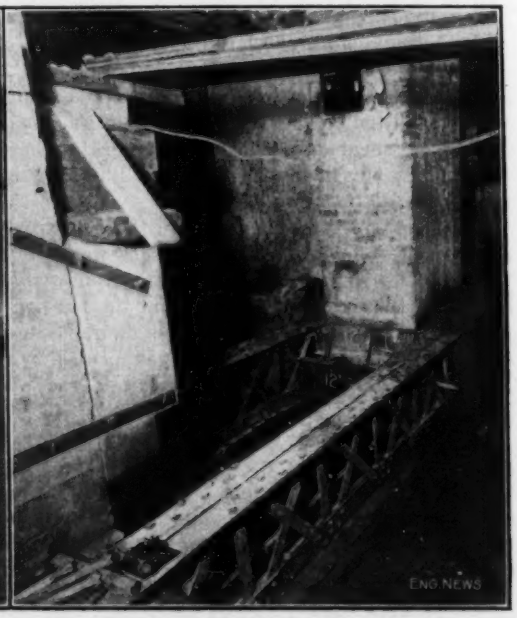

FIG. 58. UNDERPINNING WITH A LATTICED GIRDER

hydraulic- or screw-jacks reacting against the building above, as shown in the photograph, Fig. 56, and the second, to drive them by a hammer. The first is, it is stated, a patented process. Where the hammer is used it generally consists solely of a weight, about 300 lb.,

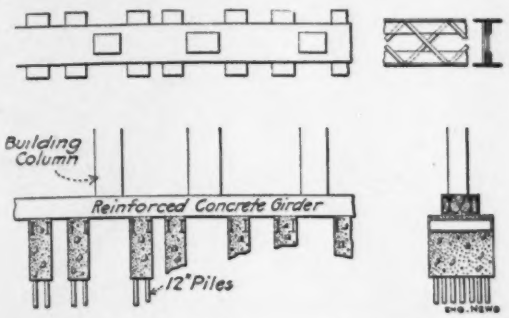

FIG. 59. SKETCH ILLUSTRATING UNDERPINNING WITH REINFORCED-CONCRETE GIRDER

suspended from a rope passing over a single block attached to the floor above the pit, and running to a small single-drum hoist. The fall is usually only a few feet and the hammer is guided by hand by a man standing near the pile being driven. A square cast-iron cap is used on top of the pile.

An interesting detail of the horizontal sheeting so generally used in sinking the pits for underpinning and other purposes is the method of chamfering the corners of the

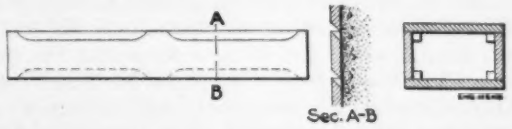

FIG. 60. HORIZONTAL SHEETING FOR SINKING PITS

boards so as to allow of packing the ground solid behind them as they are placed (see Fig. 60). The boards on two opposite sides are cut so that they fit inside those on the other sides, making a brace, and short blocks are spiked on to hold the short sides as shown in the plan. The long sides are placed first, and made to give a firm driving fit to the short ones. Each width is firmly packed as it is placed.

The pits are filled with concrete up to within about 12 or 15 in. of the bottom of the concrete girder. When the concrete in the pit has set, short sections of I-beams are placed on top of it and wedges are firmly driven between these I-beams and the bottom of the foundation girder. This holds the latter while the other pits are being put down, the shrinkage in the concrete in the pits being taken up from time to time by the wedges and the whole finally completely filled in, after all shrinkage and settlement of the new foundation have taken place.

The foundations of the Havemeyer Building (14 stories) are on spread brick piers on wooden piles, the bottom of the brick and the top of the piles being at approximately the level of the floor of the subway. To protect these foundations, additional hollow steel piles were sunk under the front edges of the building piers and then a double row of steel sheet piling 10 or 12 ft. long and with a space of about 3 ft. between the rows was driven as additional protection. This acts as a coffer-dam and not only will tend to prevent any disturbance of the ground around the piles, but also to retain the level of the ground water.

In turning from Church St. through Vesey St. to Broadway, it was necessary to obtain easements under private property at each of the corners in order to get around. One of these is under Trinity Parish House and the other under the old Astor House. That portion of the latter under which the tunnel passes was dismantled and taken down, the city agreeing to provide foundations for a new building along each street line. Open trenches were sunk through the sand to a depth of about 30 ft. and from the bottom of these trenches pneumatic caissons are being sunk to the required depth. The sinking of the caissons is done under a special subcontract by the Foundation Company.

The Trinity Parish House is a four-story brownstone building about 30 ft. wide and 160 ft. long. The tunnels pass under it as shown in the sketch, Fig. 61. Rectangular pits were sunk as shown by the drawing, there being 115 of these pits. Part of these pits supported the building directly; at other places the walls are supported on cross-girders over the tunnel, as indicated on the sketch. With the exception of part of the ground floor and basement the building has been continuously in use during the whole operation.

A method of underpinning was developed on Sec. 3 of Route 5 (see Fig. 42) by the Underpinning & Foundation Co., which consists essentially of the construction of a retaining-wall the face of which is practically at the neat line of the structure. This is made practicable by reason of the fact that along most of the route the space underneath the sidewalks is occupied by vaults used by the

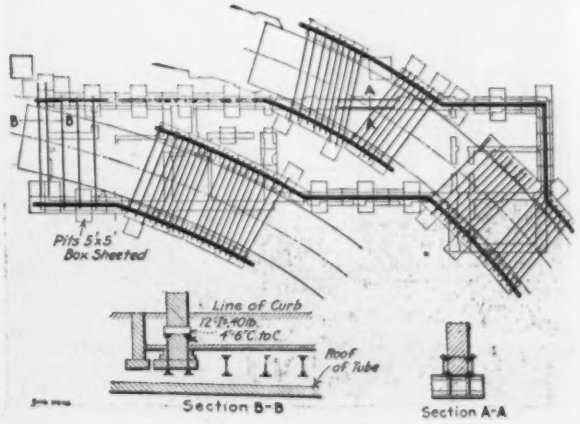

FIG. 61. LOCATION OF SUBWAY TUNNELS UNDER TRINITY PARISH HOUSE

owners of the adjacent buildings under revocable permits from the city. The width of the subway structure makes it necessary to occupy part of these vaults, though any remaining portion is afterward restored for the use of the abutting property owners. Most of the excavation of this section is in sand and the depth is comparatively shallow. The contractor, therefore, took advantage of the situation to build his sidewalls as retaining walls, working from the bottom of the vaults before commencing the main excavation. This effectually prevented any disturbance of the ground under the building and lessened the amount of timber, as no bracing for the sides was required. The retaining wall was built in sections by sinking 4 ft. square pits or wells (using the horizon-

tal sheeting) separately, and some distance apart, then intermediate pits were put down and finally the whole closed up to make a continuous wall.

At the lower end of this section, the two middle tracks are depressed for the Canal St. connection, and as this is

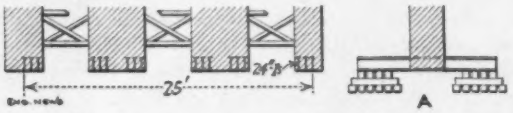

FIG. 62. UNDERPINNING WITH NEEDLES 6-STORY BUILDING, BROADWAY AND 17TH ST.

mostly below ground-water level and quite deep, the method above described did not wholly apply. It served, however, for the upper level and steel sheeting was then driven between the outer tracks and the inner pair, to enable these latter to be taken down to the required depth.

The six-story brick building at the corner of Broadway and 17th St. was held on needles while it was underpinned, and is a good example of what this method involves for a heavy building. The length of the front which was supported is about 25 ft., and eighteen 24-in. I-beams each about 25 ft. long were required to hold the weight. There were two piers between the corners and the three spaces between them were filled with heavy timber

FIG. 63. TEMPORARY SUPPORT FOR ELEVATED-RAILWAY COLUMNS

bracing and blocking before operations were commenced, as is shown in the sketch, Fig. 62. The I-beams were used in groups of three, supported on a continuous grillage built up on the cellar floor inside and on the vault floor outside. Hitches were cut, one at a time in the sides of the columns to take the three I-beams, and the whole load finally transferred to them while the foundations were carried down.

ELEVATED-RAILWAY COLUMNS

The columns of the elevated railway as originally built were generally supported beneath the surface of the street on spread brick footings, the removal of which is made necessary by the construction of the subway. Temporary supports as shown in the photograph, Fig. 63, are

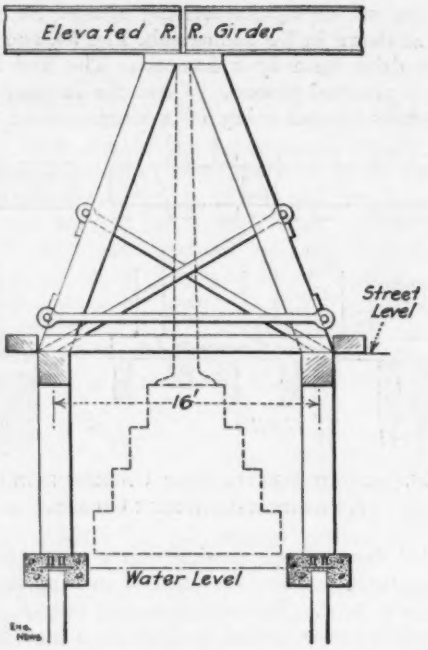

FIG. 64. SUPPORT OF ELEVATED-RAILWAY COLUMNS ON CHURCH ST.

built to hold the elevated structure during construction and considerable care is necessary to prevent any settlement and to provide as nearly as possible absolute safety.

On Sec. 1, Route 5, which is under Church St. and the Sixth Ave. Elevated, the A-frame supporting the cross-girder above the column is supported on timber bents resting on steel piles. The spread brick footings are uncovered and spaces are cleared at the two sides of the structure in each of which three 14-in. steel piles are sunk to below subgrade and to a firm bearing; these are capped on each side by a reinforced-concrete beam on which a perpendicular timber bent is erected to about the level of the street surface as shown in the sketch, Fig. 64. These bents are about 16 ft. apart and an A-frame is then erected on them. The legs of the A-frame are held together by eye-bars and pins or timber bracing, as shown in Fig. 66. When the final support of the columns is to be below or at subgrade, clusters of hollow steel piles are driven and capped with reinforced concrete, to form the new footing, as shown in the photograph, Fig. 65. In many cases, how-

FIG. 65. HOLLOW PILES FOR FOOTING OF ELEVATED-RAILWAY COLUMN

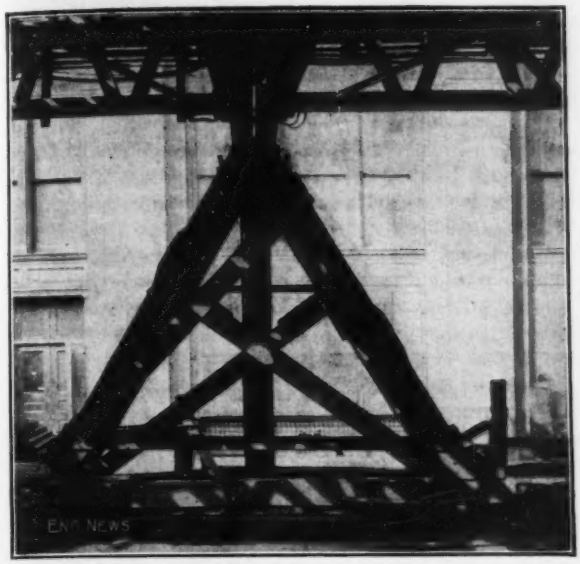

FIG. 66. TIMBER A-FRAME WITH EYE-BAR CLAMP SUPPORTING ELEVATED-RAILWAY COLUMNS, CHURCH ST.

ever, the new column footings are carried directly on the roof of the completed subway structure.

The method of support adopted where the construction of a new sewer, on Third Ave., required temporary support of one pair of columns, is shown in the photograph, Fig. 66, the structure being blocked up from two pairs of girders laid direct on blocks on the paved surface of the street.

On West Broadway, at the lower end of the Seventh Ave.-Varick St. line, the elevated columns are supported above the street surface by a timber tower. Immediately below this and supporting it are two heavy 30-in. Bethlehem beams about 20 ft. long, laid on either side of the brick footing parallel to the street line. Both ends of these are in turn supported by a pair of 24-in. I-beams which rest on timber blocks on the ground outside of the brick footings.

A Year of the Commission-Manager Plan at Titusville, Penn.

BY L. O. BRADLEY*

As the end of the first year under the commission-manager plan of city government draws to a close in Titusville, Penn., I cannot refrain from giving my full indorsement to the plan. At the start I was strongly opposed to it and fought it, but the results obtained in less than a year convince me I was in error.

In December, 1914, the commission form of government was installed, and as soon thereafter as possible, to perfect the ordinance, the city-manager plan was adopted, and City Engineer H. A. Holstein was appointed City Manager. By this action on the part of the council, the offices of street commissioner, water superintendent and city electrician were abolished, and all departments and employees placed under the personal supervision of the city manager, who at once proceeded to systematize the whole working force under one head.

*Commissioner of Public Safety, Titusville, Penn.

A new method of time keeping has been installed, and all the purchasing of supplies is done by the manager, upon his written orders only, made out in duplicate, and all bills and payrolls pass through his hands before being paid.

In every department the buildings and equipment have been overhauled and repaired and brought up to an efficient working condition.

STREET DEPARTMENT—New methods of cleaning the paved streets and working the unimproved streets were adopted, and laborers made to realize that working for the city meant the same as working for a corporation. The old flat rate of $1.75 per day was dropped and laborers were paid 20c. per hr. for actual time employed.

In the street department the entire equipment has been put in good repair, at a small cost for new parts and materials. This was done by regular employees, in spare time, without additional help or cost.

LIGHTING DEPARTMENT—The equipment has been overhauled, all poles, wires and suspensions have been inspected, tested and renewed where needed, putting the entire system in first-class condition, ready for the installation of a new lighting system next year, which will be strictly up to date, increasing the efficiency and number of lights, at a reduction in operating expenses of about $2500 per annum.

WATER DEPARTMENT—This department has received like attention, and it is here, no doubt, the best results have been obtained. The manager, during the early spring, caused a complete inspection to be made of all services, connections and fixtures, resulting in a readjustment of the water rates throughout the city, putting them on a uniform basis, without favor to anyone, thereby increasing the revenue in the department about $3000 per annum. No change of rates was made.

The service has been greatly improved, while the consumption of water has materially decreased. This is clearly demonstrated by the quantity of water in the wells, the reduction, by about two tons per day, of the coal consumed, and an increased pressure throughout the city.

After a systematic test of various kinds of coal, a better quality of coal has been obtained at a reduction of 11c. per ton. New lines have been installed, and leaks repaired continuously throughout the city.

FIRE AND POLICE DEPARTMENTS—These have been brought up to a high state of efficiency both as to men and equipment, and a new, modern police station is in process of construction, according to plans and specifications prepared by the city manager.

FINANCES—The present council came into office handicapped by a deficit of about $2500, caused by the previous council overdrawing department funds, and further, by the loss of $1200 in liquor license taxes, caused by the reduction of the number of licensed saloons in the city.

No increase was made in the tax levy, and it is now an assured fact that the finances of the city will show a balance on the right side of the ledger at the end of the fiscal year.

Electric Lighting for Trains is to be adopted on all the lines of the State Railways of India, according to orders issued by the Government Railway Board. At present about 13,300 cars are lighted with Pintsch gas and about 5600 with electricity. It has been for some years the practice to equip all first, and second-class cars and all dining cars with electric lighting and electric fans, the latter being especially advantageous for the torrid climate.

A Comparison of the Economy of Powdered Coal, Oil and Water Gas for Heating Furnaces

By C. F. Herington*

Oil

Of the three fuels, powdered coal, oil and water gas, fuel oil has come into use far more than any other. The U. S. Navy yards have been consistent in their adoption of it. All now use fuel oil for heating operations, many to the complete exclusion of coal.

Without a doubt, fuel oil is one of the easiest of fuels to handle; it can be carried in pipes anywhere so long as there is air pressure or pump pressure behind it. It requires only a comparatively small outlay for equipment—all that is necessary is a couple of storage tanks, a pump to fill the storage tanks from the cars, a piping system to the furnaces, and means to secure the necessary pressure.

But fuel oil has one disadvantage—and this is conceded by many to be a big one; the price is constantly going up. Ten years ago, fuel oil could be bought for 2½c. a gal., and one could contract for any quantity at that price; now it is 4½, 5 and 5½c. a gal., and one has to take what quantities he can get at that price. Present conditions indicate that this advance in cost will continue beyond the limits of economy.

Powdered Coal

Steady increase in the price of oil has led, quite recently, to extensive experiments in the use of powdered coal and of water gas and producer gas as substitutes. As a fuel for burning under boilers, powdered coal may some time be a success. The use of powdered coal in portland-cement manufacture has proven very economical and here it has come to stay. But when it is claimed that it is equally good for various heating operations, such as welding, shingling, annealing, riveting and forging, there is likely to be a difference of opinion.

In a recent article in an engineering paper, the following advantages were claimed for powdered coal:

(1) "Complete combustion, doing away with losses due to the carbon contained in the ash and in the escaping volatile matter." This is not correct, for if one stands for an hour watching one of these furnaces working, as the writer did, he will be completely covered with fine, unburned powdered coal which has escaped through the furnace doors. This has become such a nuisance to the surrounding machinery and workmen that attempts are now being made to relieve these conditions by placing a hood over the furnace door and connecting it into the furnace stack. This has not proven successful as yet, and probably will not until an exhaust fan is provided to discharge this unburned coal through the roof.

(2) "Total absence of smoke." Certainly this is not true inside of the shop, for powdered-coal furnaces, due to their ununiform feed, smoke worse than oil. Powdered coal, as is well known, must be very dry to be pulverized and, when pulverized and allowed to remain quiet for 48 hours, it cakes and requires that a man knock on the bins to loosen it. This leads to uneven combustion in the furnace with large quantities of smoke when there is a large amount of coal coming through the burner and no smoke when the coal is sticking back in the bins. No doubt this is largely due to inefficient handling of the feeder and burner; even so, a total absence of smoke cannot be claimed when such conditions are met.

(3) "A cheaper grade of coal may be used." The best coal for powdered fuel has a volatile content of not less than 30%, not more than 80% ash, and 1¼% sulphur. I think the readers will agree that coal meeting these specifications is of no very cheap grade.

Pulverized coal must be handled with great care, for if it is mixed with any quantity of air, it is highly explosive, as the records of accidents in cement plants will prove. In the January issue of the *Quarterly of the National Fire Protection Association*, the following appeared regarding the hazards of drying pulverized coal:

> Under no circumstances is it recommended that the products of combustion be allowed to come in contact with the coal to be dried. . . . Already there have been quite a number of accidents from this cause in which lives were lost.
>
> A characteristic coal mill explosion (March 2, 1903), in New Village, N. J., at the Edison plant, killed six men and burned five others, perhaps fatally, besides injuring a score of others and destroying the coal building. It is supposed that the pulverized coal in bin fired spontaneously and some of the burning fuel was carried by the automatic conveyor into the blower house. The atmosphere of the blower house being charged with coal dust, an explosion was the result.
>
> On August 19, 1900, an explosion in the plant of the Nazareth Cement Co., Nazareth, Penn., caused a loss of $16,000, while on November 26 of the same year $40,000 damage was done to the Martin's Creek Portland Cement Co. (then known as William Krause Sons), Martin's Creek, Penn. The Dexter Cement Co., Nazareth, Penn., and the Alpha Portland Cement Mill No. 1, Alpha, N. J., had similar experiences the same year.

Another very serious objection to powdered coal, due to the incomplete combustion of all the coal ejected into the furnace, is that this coal lies on the work, and when the work is taken out of the furnace, if not cleaned off, it is apt to be hammered into the work and make flaws which later are likely to be more or less serious according to the nature of the work. This is a fact seen from personal observation and cannot be denied.

Powdered coal is not good for small furnaces, as it requires too large a chamber for combustion, and from the experience of the users of powdered coal it is not desirable to have a combustion chamber separated by a bridge-wall from the working chamber. It is found that the lesser of two evils is to remove the bridge-wall and blow the powdered coal directly upon the work, which aggravates the condition mentioned above. If the large furnaces are changed from fuel oil to powdered coal, there still remain the small furnaces, and especially the portable ones, which will have to work on fuel oil. Then there would be the expense of handling two kinds of fuel where before there was but one.

The pulverizing plant is to be considered. When it is reported that it costs only 30 to 50c. a ton to perform a multitude of operations, I feel that some one has misplaced the decimal points, as will be shown later on.

Gas

Greater familiarity and extended experience with natural gas for power and metallurgical purposes have led to better appreciation of the many advantages of gaseous fuel. It has emphasized the value of the gas producer for converting solid into gaseous fuels. But such conversion always involves a loss of a part of the energy of the coal; it is only because the gas can be utilized more

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efficiently that the duty obtained from it is greater than that given by the direct burning of the coal from which it is generated. Hence, any process which claims to deliver in the gas an amount of energy greater or even equal to that in the original fuel is a delusion or worse.

There are at present two kinds of made gases used for heating furnaces—producer and water gas. Industrially, producer gas is the combustible product of rather a complex series of physical and chemical changes induced in the fuel by the heat arising from its incomplete combustion in the producer. The combustion is termed incomplete not in the sense of leaving an unburned residue of carbon or coke, but because the combustible while completely gasified gives up only about 30% of its heat in primary combustion in the producer. The remaining 70% is developed when the gases are burned after leaving. Water gas is made by an intermittent process—first using an air blast to bring the fuel to high incandescence, then shutting off the air and forcing steam through the fire. During the air blow, a lean producer gas is made which may be enriched by the addition of water gas of a higher calorific value and used in the low-temperature furnaces or to drive gas engines. The true water gas is made during the steam blow, the steam being decomposed by the incandescent carbon so that its hydrogen is freed and its oxygen united with the carbon to form carbon monoxide.

The water gas can be used for all purposes where high temperatures must be secured without regeneration, as in factories carrying on a large variety of brazing, small forge, work, etc., where the furnaces are small and distributed over a large area. Temperatures ranging from 2500° F. to 2900° F. are easily obtainable with this gas, and with properly constructed furnaces it is possible to gain an added efficiency in operation so that the total B.t.u. in the gas used need be only 66 to 80% of the B.t.u. required in oil as used in approved oil furnaces for the same purposes. Water gas does not cause the metal forged to scale as does oil, and with gas it is possible to get a closer regulation of furnace temperatures.

Comparative Efficiencies

Now comes the debatable point of what is the efficiency of the furnace when using the different fuels. The powdered coal advocates will claim that the efficiency should be figured on the B.t.u. basis. That is, if a furnace burns say 22 gal. of oil to do a certain piece of work and each gallon contains 140,000 B.t.u., 3,000,000 B.t.u. in all, it will take 3,000,000 B.t.u. in coal to do the same work, but the coal is cheaper. If oil were 5c. a gal., it would take coal at $10 a ton to equal the cost; so the reader will perhaps agree that this is not the proper method of comparing efficiencies, any more than saying that the cost of gasoline per gallon is the operating cost of running an automobile.

The true way is to measure the efficiency of the furnace by the comparison of the input and output, and below are given results of some efficiency tests, made by the writer for a well known concern contemplating a revision of its furnace practice.

POWDERED COAL—(Furnace using preheated air for combustion).
Furnace cold at 60° F.
Steel and furnace heated to 2200° F.
Rise in temperature, 2140° F.
By test, 6.29 lb. of steel heated per pound of coal burned.
Specific heat of steel, 0.117.
0.117 × 2140 = 250 B.t.u. per lb. of steel.
250 B.t.u. × 6.29 = 1572 B.t.u. output.
1 lb. of coal = 14,000 B.t.u., input.

$$\text{Efficiency} = \frac{1572 \times 100}{14{,}000} = 11.3\%.$$

FUEL OIL—Same furnace with same rise in temperature and the same charge of work.
Heated 8.68 lb. of steel per pound of oil.
1 lb. of oil = 19,400 B.t.u., input.
250 B.t.u. × 8.68 = 2170 B.t.u., output.

$$\text{Efficiency} = \frac{2170 \times 100}{19{,}400} = 11.3\%.$$

WATER GAS—(Furnace using preheated air for combustion).
1 cu.ft. of gas = 300 B.t.u.
Specific heat of wrought iron = 0.113 (Kent).
Temperature rise from 1400° to 2500° = 1100° F.
Furnace charged with 3800 lb. iron.
To raise this iron to that temperature required 14,000 cu.ft. of gas.
0.113 × 1100 = 124 B.t.u.
3800 × 124 = 471,200 B.t.u., output.
14,000 × 300 = 4,200,000 B.t.u., input.

$$\text{Efficiency} = \frac{471{,}200 \times 100}{4{,}200{,}000} = 11.2\%.$$

Another furnace using fuel oil. (Not using preheated air).
Temperature rise from 1200° to 2200° = 1000° F.
Charge of wrought iron, 2150 lb.
Oil required, 22 gal.
2150 lb. × 113 B.t.u. = 242,950 B.t.u., output.
1 gal. oil = 140,000 B.t.u.
140,000 B.t.u. × 22 = 3,080,000 B.t.u., input.

$$\text{Efficiency} = \frac{242{,}950 \times 100}{3{,}080{,}000} = 7.88\%.$$

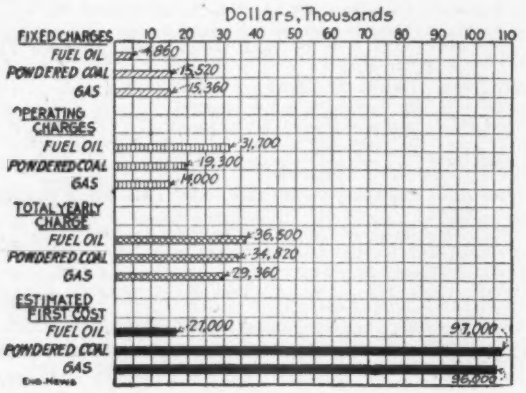
First Costs

In making comparison as to the relative first costs and operating costs with the three kinds of fuel, let us assume a plant now using fuel oil with a consumption of 50,000 gal. of oil per month at a cost of 5c. per gal., delivered at the shop. (These estimates were made for the company already mentioned.)

(1) FUEL OIL:	
Cost of equipment (storage tanks in place, auxiliary pressure tanks in place, piping and fittings in place, steam connections, furnace connections, tank-car connections, tank pumps and air-blast outfit)	$21,100
Contractors' profit (15%)	3,165
	24,265
Engineering and contingencies (10%)	2,435
	26,700
(2) POWDERED COAL:	
Pulverizing machinery, house, foundations, trestle and track, electric wiring, conveyors, walkways, motors, burners and controllers (30), furnace bins (30), furnace changes, hoods and connections, etc.	$68,100
Contractor's profit (15%)	9,900
	78,000
Engineering and contingencies (10%)	7,800
	85,800
(2A) FUEL OIL FOR SMALL FURNACES:	
Tank in place, auxiliary tank in place, piping and fittings, furnace connections, tank-cars connections, pumps, air blast, etc.	$8,800
Contractor's profit (15%)	1,300
	10,100
Engineering and contingencies (10%)	1,000
	11,100
(3) WATER AND PRODUCER GAS PLANT:	
Gas-making machinery, building, trestle and siding, piping, furnace changes	$76,000
Contractor's profit (15%)	11,000
	87,000
Engineering and contingencies (10%)	8,700
	95,700
SUMMARY:	
Fuel oil	$27,000
Powdered coal with fuel oil	97,000
Gas plant	96,000

Fuel Consumption of Plants

For the fuel-oil plant, at 50,000 gal. of oil per month and 140,000 B.t.u. per gal., 7,000,000 B.t.u. are consumed per month. If we allow 10 lb. of coal, at 14,000 B.t.u., equal to 1 gal. of oil, we have 500,000 lb. or 250 tons of coal used per month, for the powdered-coal plant. In addition, this plant consumes about 8000 gal. of oil, the difference being compensated for by coal required in drying the main fuel supply. For the gas plant, we require about 60,000 cu.ft. of water-gas per hour; at 20 cu.ft. per lb., we require 3000 lb. of coal per hour or 375 tons per month.



Diagrammatic Comparison of Estimated First Cost and Annual Charges of Coal, Oil and Gas Plants to Supply Fuel for 30 Furnaces

Total Costs

Now the total charges can be assembled.

FUEL OIL PLANT—(Estimated cost, $27,000).

Fixed charges:		
Interest (5%)	$1,350	
Depreciation (12%)	3,240	
Taxes and insurance (1%)	270	$4,860
Operation:		
Oil, (50,000 × 0.05 × 12)	$30,000	
Labor, 1 man	1,000	
Electrical current, steam, air	500	
Miscellaneous supplies	200	$31,700
Total yearly charge		$36,560

POWDERED COAL PLANT—(Estimated cost, $97,000).

Fixed charges:		
Interest (5%)	$4,850	
Depreciation (10%)	9,700	
Taxes and insurance (1%)	970	$15,520
Operation:		
Coal (250 × 2.50 × 12)	$7,500	
Oil (8000 × 0.05 × 12)	4,800	
Labor (1 operator, 2 assts.)	2,000	
Electricity for motors	5,000	$19,300
Total yearly charge		$34,820

GAS PLANT—(Estimated cost, $96,000).

Fixed charges:		
Interest (5%)	$4,800	
Depreciation (10%)	9,600	
Taxes and insurance (1%)	960	$15,360
Operation:		
Coal (375 × 2.50 × 12)	$11,250	
Labor (1 operator, 2 assts.)	2,000	
Water	744	$14,000
Total yearly charge		$29,360

These several figures are plotted on the accompanying diagram for easy comparison.

A Heavy Cut for a Street at Kansas City

One of the municipal improvements around the new union station at Kansas City, Mo., is the extension of Main St. through the high bluff fronting the station, and this work has involved a very heavy cut, known to local engineers as the "Culebra Cut."

Construction

The improvement represents two stages of construction. An ordinance for the work as originally planned was passed in 1908, and a contract was awarded in 1910 for grading the street to 60 ft. width for a distance of 2450 ft. The work was accepted Aug. 27, 1913, and included the removal of 259,963 cu.yd. of earth, rock and shale at 74⅜c. per yd., or $193,347. Of the total quantity, about 70,000 yd. was due to caving and slippage. The earth removed was hauled about 800 ft. from the north end of the cut and used for filling low ground. The rock was crushed and sold.

Before this contract was completed, the Kansas City Terminal Ry. made some changes in the grade of the union station and enlarged the station plaza, making it necessary to lower the grade of Main St. about 8 ft. at the south line of 24th St. The company leveled to the new grade its property between 23d and 24th Sts. As soon as the first contract for grading Main St. was completed, it was necessary to let another contract cutting 8 ft. deeper at the north line of 24th St. and running out to the original grade at Grand Ave. It was also deemed advisable to widen Main St. from 60 ft. to 90 ft. The estimated quantity to be removed was 115,000 cu.yd., at 96½c. per yd. This contract extended over a distance of 1930 ft. and the cut is 90 ft. wide at the bottom, the maximum depth of cut being 82 ft.

This recent contract is about 60% completed. There will be probably about 35,000 yd. of slippage on the sides, increasing the total quantity to 150,000 cu.yd., or a total of $144,750. This material is being excavated by three steam shovels. At the north end, a narrow-gage railway

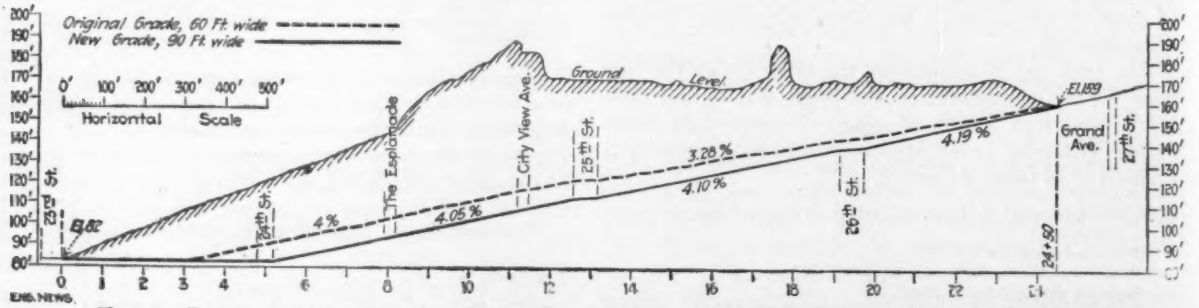


Fig. 1. Profile of Extension of Main St. through a Bluff or Ridge at Kansas City, Mo.

FIG. 2. DEEP CUT FOR MAIN ST., KANSAS CITY, LOOKING SOUTH FROM THE ESPLANADE

FIG. 3. MAIN ST. CUT DURING CONSTRUCTION, LOOKING NORTH AT 26TH ST.

extending about 2000 ft. and crossing several city streets provides for making a fill in front of the city hospital grounds. At the south end, the material is being hauled by wagons to various places on neighboring property which is below grade. It is planned to install another narrow-gage railway south and west to 31st St., about 3000 ft., and to use the material for filling low property in that vicinity. It is expected that this grading will be completed by May, 1915.

The contract calls for cutting the sides vertical, but all slippage occurring before the work is finally completed must be removed, and the City Engineer has the power to order the contractor to remove any unsafe or overhanging ledges. The material is earth, solid rock and shale, and as about half the cut is shale and rock, the sides will stand on a slope of from ½ : 1 to 1 : 1. The contract is held by Spitzcaufsky Bros. All payments are by special tax bills.

The difficulties encountered included caving, and slides due to rain, the latter sometimes burying steam shovels and tracks. As no definite slopes are specified, the sides may be left as they stand at present, with the possibility of slides after heavy rains. Owners of property along the top of the cut must take care of their own property, having been paid damages. There was some trouble with the blasting, to avoid damage to buildings by the shocks as well as the throwing out of material. Difficulty was experienced in removing the excavated material promptly, as the narrow-gage track crosses several streets carrying heavy traffic, and its grades are steep for the dinkey locomotives, while the haul is rather long.

The city is planning to improve its property on the west side of Main St., between 24th and 25th St., as a park, terracing and grading down portions of it at an estimated total cost of about $350,000. The whole of this work will not be done at present, but it is expected that next year about $100,000 will be expended on this park. Some of the private property owners are already grading down their property and preparing to build. The city has started proceedings on the grading of the Esplanade from Grand Ave. to Main St., on which the maximum cut will be about 75 ft., at an estimated cost of about $60,000. It has not been decided what will be done with 25th St.

ASSESSMENTS AND DAMAGES

For the first work on Main St., court proceedings resulted in an award of $49,117 as damages to abutting property on account of the cut. This amount was assessed against the frontage on Main St. between Ninth and 31st Sts., an arbitrary benefit district being fixed by the City Engineer and the City Council. This amount for damages went to the abutting property between the points to be graded, and the cost of grading was assessed against the property half way through the blocks on each side of the street between the points graded. The contractor received no pay until the work was entirely completed, and then was paid in special tax bills against the property.

The regrading and widening proceedings were sent to court and a verdict was returned Dec. 22, 1913, allowing the property owners between 24th St. and Grand Ave. an additional $32,350 for grading damages due to lowering of the old grade, and $41,265 for the 30 ft. of ground condemned (on the west side) in the widening proceedings. About 500 ft. of the ground taken in the widening was

from the Union Station Park, between 24th and 25th St., which is owned by the city, and for this the city received no pay.

These damages were assessed against a benefit district of the abutting property on Main St. between 12th and 35th St., 2½ miles. Through a waiver of the property owners, the city was allowed to proceed immediately with the work, pending the collection of these benefits, and a contract was let and confirmed on Jan. 27, 1914. The total cost ($144,750), as in the first case, will be assessed half way through the blocks on each side of Main St. between 24th St. and Grand Ave., and special tax bills will be issued.

In the court proceedings outlined above, the property owners within the limits to be graded may submit evidence in court to a jury of six freeholders of the amount their property is damaged by cuts or fills. The jury views the ground, decides on the amount of damage each owner is entitled to, and spreads the total damages over the property in the benefit district. This is usually in the form of a graduated tax per front foot, decreasing as the distance from the work increases. A large part of the damages allowed are usually offset by benefits as the property abutting the portion to be graded is benefited as much or more than any other property in the benefit district when damages are not considered. The amounts given are the net amounts allowed as damages after benefits have been deducted.

For information as to the work described and the methods of assessment, etc., we are indebted to C. R. Mandigo, Assistant City Engineer of Kansas City, Mo.

Rail Failures and Train Accidents

The frequency of rail failures on American railways has been a source of trouble and anxiety for some years, but the fact that relatively few train accidents have been caused in this way has led to the impression that the conditions are not very serious in this respect. Inquiry shows, however, that the number of rail failures is very large and constitutes a serious problem, while the comparatively small number of accidents is due probably to careful watching and protection of the track. This matter has been discussed in our issues of Aug. 13 and Oct. 1, and we give below the results of inquiry as to the conditions on five leading railways. We have discussed the matter further in our editorial columns.

Railway No. 1 (4500 miles)—During the calendar year 1912 this road had 1894 broken rails, of which 56 (or 3%) caused derailments. None of these derailments were serious.

Railway No. 2 (3000 miles)—The statistics in Table I are for the calendar years 1912 and 1913. While none of the accidents resulted seriously, it must be borne in mind that any accident due to a broken rail is a serious matter.

TABLE I. RAIL FAILURES AND ACCIDENTS: 1912 and 1913 (Ry. No. 2)

Weight of Rail	100 lb.	85 lb.	70 lb.	60 lb.	Total
1912					
No. of all rail failures	406	2519	211	269	3495
No. of broken rails	177	836	129	72	1214
No. of derailment or accidents due to broken rails	1	4	0	0	5
1913					
No. of all rail failures	338	930	58	78	1404
No. of broken rails	119	189	19	27	354
No. of derailments or accidents due to broken rails	0	2	0	0	2

Railway No. 3 (6500 miles)— Regarding derailments due to broken rails, an improvement in the quality of the rail, from a safety standpoint, will reduce the number of rails which break in service and (other things being equal) the number of derailments occasioned thereby. A comparatively small number of derailments due to broken rails may indicate that good rails are being used, but does not prove this, for the reason that the good results obtained may be due (in large degree) to the use of automatic block signals and high-grade maintenance-of-way methods resulting in detection and removal from the track of many rails which might have caused derailments.

In rail statistics, this road rates as "failed" not only rails that break but all rails that have developed defects of any character which would make their retention in the track unsafe. As their removal is a precautionary measuse, in all probability many of these rails could have been continued in service for a much longer period without breakages, while others might have lasted indefinitely. The result of this practice is that the ratio of the so called rail failures to breakages is high, the actual proportion being unknown.

The number of rail failures recorded for the fiscal year ending June 30, 1913, is 1431. There were 11 derailments or accidents due to broken rails during the same period, with 12 passengers and employees injured (none killed), and slight damage to property. None of the accidents were serious. The following statistics for the same period are of interest in showing the very high degree of safety resulting from good rails combined with the use of signal systems and efficient maintenance methods. The statement includes both passenger and freight served.

Gross ton-miles per person injured due to broken rail	2,793,856,666
Gross ton-miles per derailment due to broken rail	3,047,843,636
Passengers and employees injured per derailment on account of broken rail	1.09

Railway No. 4—The statement in Table II shows the rail failures and accidents caused by rail failures for the six years from Oct. 31, 1907, to Oct. 31, 1913. Failures of rail of 70 lb. per yd. or less and failures in other than main tracks are not reported. All accidents resulting from rail failures are reported, including those on light rail and other than main tracks. The cost for damage to freight, equipment and track, and for clearing wreck, exceeded $150 in the case of five freight derailments in 1912 and two passenger and five freight derailments in 1913.

TABLE II. RAIL FAILURES AND TRAIN ACCIDENTS (Ry. No. 4)

Year	Failures	Derailments Due to Rails: Passenger	Freight	Total
1908	3065	6	14	20
1909	2056	3	12	15
1910	1749	8	12	20
1911	1882	3	11	14
1912	3349	1	16	17
1913	2527	4	9	13

Railway No. 5 (700 miles)—From Sept. 30, 1913, to Sept. 30, 1914, this road had a total of 263 broken rails, none of which resulted in a derailment or train accident of any kind.

An abstract of all the figures is given in Table III.

TABLE III. RAIL FAILURES AND TRAIN ACCIDENTS ON FIVE RAILWAYS

Road	Year	No. of Broken Rails or Rail Failures	No. of Derailments Due to Broken Rails	Rail Failures per Accident
1	1912	1894*	56	34
2	1912	1213*	5	242
2	1912	3495†	..	604
2	1913	354*	2	177
2	1913	1404†	..	702
3	1913	1431†	11	131
4	1913	2527†	13	194
5	1913-14	263*	none	...

* Broken rails. † Rail failures.

It will be noted that in this table a distinction is drawn between broken rails and rail failures, the latter including rails found to have defects of any character which make it necessary to remove the rails as unsafe. The figures relate to main-track only, and to rails of 70 lb. per yd. and upward. But in at least one case (No. 4) the accidents include those on lighter rail and tracks other than main track.

A notable development during the past few years has been the increasing use of openhearth rails. In regard to such rails, P. H. Dudley, Consulting Engineer for the New York Central Lines, says that the most important work now in hand is the production of basic openhearth rails in which the failures are reduced to a small fraction of those which occurred in the former bessemer rails. He states that the breakages which occur during cold weather are often due to the high tensile stresses from contraction before the rails give or slip in the splice bars, but such fractures rarely cause derailment, as the metal is not brittle and there is simply the fracture or open joint across the rail.

The basic openhearth rails on the above road include 519 miles of 80 lb., 530 miles of 100 lb. and 408 miles of 105 lb. Up to Sept. 1, 1914, the number of broken rails per 100 miles was 1.93 and 0.57 for the first two and none for the last. There was exceedingly cold weather last winter, and the results showed that the failures of the basic openhearth rails and the bessemer rails were as 1 to 22 under the same conditions of locality and traffic.

A New Cast-Steel Clamp for Guard-Rails

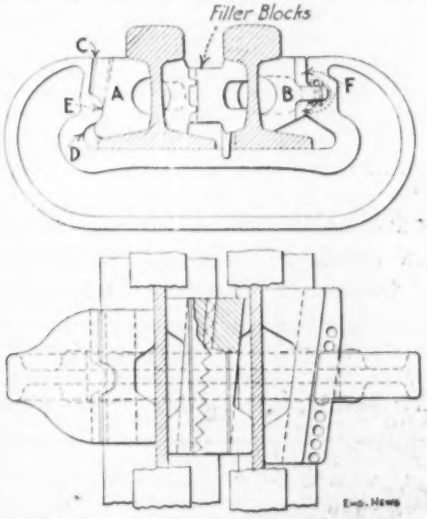
A recent design of guard-rail clamps, for maintaining frog guard-rails in proper relation to the adjacent running rails, is shown in the accompanying cut, and presents some special features. In general it consists of a heavy cast-steel yoke, with blocks and wedges between it and the rails and with filler blocks between the two rails. These latter blocks are wedge-shaped and with serrated contact faces, so as to be adjusted to give the desired width of throat or flangeway.

In fitting the clamp, the two filler blocks are first placed between the rails (being adjusted to the desired spacing), and the guard-rail is then spiked in place. The yoke is next placed and the outer block *A* inserted, and then the inner wedge *B* is inserted and driven home until the clamp is tight. This wedge is held from slacking back by means of a cotter pin and the block is secured in place by a rounded lug on the face of the yoke. The lug also holds the block firmly down upon the base of the rail. The filler blocks are prevented from slacking by means of a lug which engages the bottom of the yoke, as shown.

The yoke is of H-section, having heavy top and bottom flanges to reinforce the web. One of the principal features is the width of the end bearing outside the main rail, the purpose of this being to maintain the yoke at right angles to the rail.

The makers state that it has been found, in experimenting with such clamps, that even on well ballasted track the outer end of the clamp would move vertically, as wheels passed over the rail, causing the point of contact to shift. This would increase gradually, and with the point of contact at the top of the yoke *C*, there would be excessive stress at *D* tending to break or spread the yoke. To prevent this, the face now has the rounded projection *E* and a slight clearance at the top, so that the point of contact is permanently at this projection. The contact at the opposite end of the yoke is at *F*, with no contact against the rib through which the cotter pin is inserted.

The cast steel used is heat treated and has a tensile strength of about 72,000 lb. The weight of clamps complete for 80- to 100-lb. rails averages 50 to 55 lb. Two clamps to each guard-rail are recommended for main-track service. These guard-rail clamps are in use on several railways. They are manufactured by the Reading Specialties Co., of Reading, Penn.



A New Clamp for Frog Guard-Rails

Resolutions of the International Irrigation Congress

Among the resolutions adopted by the International Irrigation Congress held at Calgary, Alberta, in October of this year, the following are reprinted as of interest to many of our readers:

IRRIGATION DISTRICTS—We recommend the passage by Congress of an act authorizing the Secretary of the Interior to enter into contracts with irrigation districts created under state law, by which the responsibility and control of each reclamation project arising from the Reclamation Act of June 17, 1902, may be turned over to an irrigation district organized under said law; and in the case of interstate projects, we recommend that suitable federal laws be enacted by which interstate irrigation districts may be formed; and in order that federal projects may be turned over to the land owners, as contemplated by the reclamation law, we recommend the careful revision and unification of irrigation district acts by the states of the arid regions, to the end that such projects may be turned over to the control of the settlers through such agency.

ENGINEERING EXAMINATIONS FOR FINANCIAL SAFEGUARDS—Full examination should be made by experienced engineers in the employ of the national, state and federal governments in advance of financing the construction of each large irrigation project, and that no such enterprise be entered upon by the governmental agencies unless it appears that such projects return at least 3% of the total investment for land and construction.

INTERSTATE WATERS—We hold that federal control as between those states which are not in full possession of their natural resources is essential to the equitable distribution and utilization of the waters of interstate streams.

RIVER REGULATION—We commend the efforts by the United States Congress to create a Board of River Regulation, and urge the enactment of suitable laws providing for

complete river regulation, beginning at the head waters and including forest protection and reservoir construction.

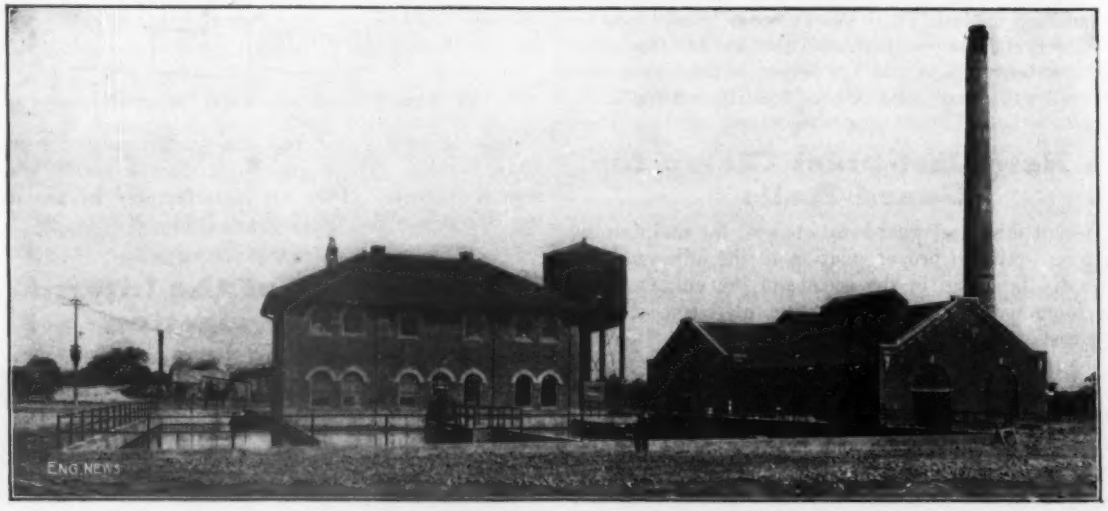
WELFARE OF SETTLERS UNDER RECLAMATION PROJECTS—We believe the United States Reclamation Service has fully carried out the purpose of the Reclamation Act in so far as the construction of engineering works is concerned. Experience has, however, demonstrated the expediency of extending to the Service additional authority to the end that it may promote, at first hand, the welfare of the settler upon the land.

STREAM GAGING AND TOPOGRAPHIC SERVICE—We urge upon the federal governments the necessity for more liberal appropriations for the work of topographic survey in hydrographic stream gaging work; and we urge stronger coöperation by the several states and provinces in making appropriations for this important work.

IRRIGATION SECURITIES—We urge that the states of the arid regions assume their proper normal and legal responsibility for the success of the Carey Act, and state irrigation districts, and pass such laws as will enable the completion of all meritorious projects now undertaken.

Water Sedimentation, Coagulation and Mechanical Filtration at Waco, Texas

A water-purification plant of unusual completeness for one of its size was put in operation early in 1914 by the City of Waco, Tex. The plant consists of two 600,000-gal. open coagulating basins, giving 6 hr. of sedimentation for 5,000,000 gal. of daily filter capacity, four 1,250,000-gal. mechanical filter units, and a 1,000,000-gal. covered clear-water reservoir. The plant is constructed of reinforced concrete throughout, except that the building which covers a portion of it is of brick, with a tile roof. Among the special features are automatic steam control of the pumps which supply the purification works, electrically driven chemical-solution agitators, Earl automatic chemical-feed and automatic filter-rate controllers, and a steel wash-water tank, in which a uniform water level is maintained automatically. A general view of the pumping and purification works is shown by the accompanying illustration.



SEDIMENTATION BASIN, CHEMICAL OR HEAD HOUSE, WASH-WATER TANK AND PUMPING STATION, WACO, TEX.

The following description of the plant has been drawn (1) from notes sent to this journal by N. Werenskiold, Consulting Engineer, Dallas, Tex., and (2) from a paper by F. B. Leopold, General Manager of the Pittsburgh Filter Manufacturing Co., Farmers Bank Bldg., Pittsburgh, Penn., prepared in the summer of 1914 for the annual convention of the Southwestern Water-Works Association.

For many years after about 1872, first one water company, then two companies, and then a consolidated water company supplied water to Waco. Finally, the works were bought by the city. Water was drawn from wells, which required supplementing by additional wells, air-lifts, etc., from time to time. In October, 1911, Mr. Werenskiold was called in by the Water Board to advise on obtaining an ample supply. In February, 1912, he recommended the Brazos River as a source, with mechanical filtration. In April, 1912, the city voted $300,000 for the new supply work, including the river connection, pump-well, pumping station and equipment, coagulating basins, filters and clear-water basin. In addition, $100,000 was voted for main extensions and a 423,000-gal. covered steel standpipe.

The intake and the short intake conduit are of reinforced concrete, as is the pump-well. The latter is elliptical in shape, 25x43 ft. in plan and 34 ft. deep.

PUMPING PLANT

The pumping plant is divided into two parts: (1) Two 6,000,000-gal. centrifugal pumps, for the low service, are driven by direct-connected vertical compound condensing engines, operating under a maximum head of 56 ft. and having a duty of over 50,000,000 ft.-lb. The steam pipe supplying these engines is provided with a chronometer controlling valve automatically operated by the changing level of the sedimentation basins. The exhaust pipes from the low-service engines are connected with the extra large condensers of the high-service engines. (2) There are two 5,000,000- to 7,000,000-gal. cross-compound condensing pumping engines, for an average head of 207 ft. and having a duty of 143,000,000 ft.-lb. Both sets of pumps were furnished and erected by the Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

PURIFICATION WORKS

General plans and specifications for the purification works were prepared by Mr. Werenskiold, and bidders were invited to submit detailed plans and corresponding prices. The contract was awarded to the Pittsburgh Filter Manufacturing Co.

MIXING CHAMBER—As originally designed, the coagulants were to be introduced at the entrance to a mixing chamber of 150,000-gal. capacity. This chamber was 50x54 ft. in plan and 15 ft. deep, and was so divided as to have a waterway 16 ft. wide. Numerous vertical baffles were placed in this waterway. This worked well when the turbidity of the water was low, but, Mr. Werenskiold states, with high turbidities, sediment was deposited in the mixing chamber. The representative of the filter company therefore "removed nearly all the baffles, changed the point of application of the iron and lime to near where the water entered the distributing pipes and placed a baffle in front of these pipes, where they enter the sedimentation basins." By this means the "mixing chamber was practically converted into a small sedimentation basin, allowing nearly an hour for plain sedimentation, and thereby relieving the raw water from the heaviest sediment before the application of the chemicals," thus avoiding "the error of burying expensive chemicals in heavy mud, where the mud can be gotten rid of without cost."

SETTLING BASINS—The two settling basins are 50x115 ft. in plan and 16 ft. deep, and can be operated singly, in parallel or in series, thus giving considerable flexibility.

The following description of the chemical-feed tanks and their control and of the filters and their operation and control is taken from the paper by Mr. Leopold, already mentioned:

The plant is designed for the use of lime and iron and hypochlorite, but alum can be used if desired. It has, however, so far been used with lime and iron and the results have proven most excellent with a turbidity of as great as 22,000 parts per million.

CHEMICAL TANKS AND REGULATING APPARATUS—The solution tanks consist of six tanks, or a pair of tanks for each solution, with dissolving boxes for mixing located on the second floor. Each tank is equipped with an electrically driven solution agitator, and the building is equipped with a hydraulic elevator for raising the coagulant from the first floor up to the storage room.

In the storage room there is a track with a traveler extending around the room and over the top of the solution tanks, so that the chemicals can be raised up to the traveler and carried in the required quantities over to the dissolving tank with the least amount of labor.

On the first floor is located the chemical-regulating apparatus. This consists of the Earl automatic controlling devices. Their function is to apply chemical solution automatically in proportion to the supply of water delivered to the coagulating basin. The apparatus consists of what is known as the master controller and the individual chemical controllers—one apparatus for each of the chemicals provided for.

The master controller is regulated by the velocity of the flow of water through the supply pipe to the coagulating basin, which, through a pilot and piezometer tube, builds up a head in the master controller corresponding to the quantity of water passing through the inlet pipe; and this head, of course, automatically changes with the quantity passing to the coagulating basin and is transferred from the master controller to the individual chemical controllers and in turn regulates, proportionately, the head of the chemical solution over the orifice feed, and in this way gives an absolute proportional feed of the chemical solutions to the quantity of water filtered.

While this apparatus is somewhat elaborate and costly, the economy in operation fully justifies its use, although in smaller plants it is not generally customary to install it. The same type of apparatus is in use in New Orleans, Minneapolis, Grand Rapids, Montreal and other places, but only in one other plant of the size of the Waco plant or anywhere nearly approaching it—that is at Fargo, N. D.

Each of the solution tanks is equipped with a recording gage which gives a definite record of the solutions that are used each day, thus giving a check on the operation of the plant also.

The solution apparatus being located directly over the inlet chamber, the supply line to the inlet chamber is extremely short and the usual troubles from this source are practically eliminated.

On the first floor is also located the laboratory, which is complete in its equipment, and up to the standard found in most of the larger plants in the country.

The filter building proper consists of a one-story building extension from the head house and the filters are four in number, two located on each side of a central gallery. They are equipped with hydraulic valves, operating tables and recording loss-of-head gages which give a record of the operation of the filters.

FILTER BEDS—The filter beds themselves are rectangular concrete units and are equipped with both air and water for washing purposes. Each bed is equipped with three wash troughs of a diamond shape, open at the top. The peculiar shape of this design is to prevent the loss of sand during the washing operation that occurs where a straight-side trough is used. The water is delivered into the filters from a conduit that is carried through between the two rows of filters and passes into an inlet chamber at one end and from there is distributed through the overflow troughs to the sand bed. It passes down through the sand bed in the usual manner and is carried out through the strainer system and through the effluent pipes into the gallery. Here it passes through the Earl type of automatic rate controller into the clear well.

RATE CONTROLLER—This rate controller provides against the filter operating to exceed its certain maximum rate, but within the maximum rate it automatically controls the filters to maintain a uniform level of water in the clear well; in other words, as the consumption decreases and the water level in the clear well rises, the filters are gradually closed off and the rate of flow decreased until when they arrive at a point where the maximum level of the water in the clear well is reached, they are completely closed off without attention from the operator. If the service pump then operates at a rate requiring the full capacity of the filters to supply them, the water gradually receding in the clear well, the filters are automatically and gradually opened to supply the increasing need until the limit of maximum flow is reached, which they are not allowed to exceed but which will be maintained until the consumption has so decreased again that the water level in the clear well gradually rises and again puts them under control. This is accomplished by a master controller which controls all of the individual rate controllers. This master controller is connected to the clear well and the difference in the level in the clear well is used to control the rate of filtration in the filter. The master controller operated by this head then in turn connects to each one of the individual rate controllers. There is also the advantage, if that is desired, that each individual filter-rate controller can be disconnected from the master controller and operated independently as a fixed-rate controller, or as an adjustable-rate controller, in this way giving the greatest flexibility of control of any apparatus that has so far been devised for this purpose.

It will be seen, therefore, that this plant is practically as nearly automatic in its control from the time the water enters the settling basin until it is taken out of the clear-water basin as it seems possible to devise. It is the only plant that the writer knows of so thoroughly equipped with automatic devices. Many of the larger plants have some of these devices but the writer knows of no plant that is completely equipped with them.

WASH-WATER TANK—For washing, a steel tank is used instead of the usual wash pump, for several reasons: One is, that under equal conditions the wash tank is preferable, as it gives a uniform pressure that is almost impossible to secure from a pump; another reason is that conditions here were hardly equal. The water could be supplied to the wash tank with the high-duty pump, probably a little more cheaply than it could be pumped with the ordinary centrifugal pump direct; also the clear-water well being located some little distance from the filter plant, pump connections would have been rather inconvenient and complicated to make. The wash tank is supplied automatically from the main. When filled, the supply pipe is closed. As the washing operation is started and the water level in the tank begins to recede, the supply valve is automatically opened and remains open until the water level in the tank again reaches its maximum level, when it is automatically cut off.

According to information from Mr. Werenskiold, the wash-water tank is a 50,000-gal. covered elevated steel structure, with its top 41 ft. above the filter-operating floor, and "is provided with a Golden-Anderson controlling-altitude valve to prevent overflowing."

W. M. Sleeper is Chairman and E. L. Fulkerson is Secretary of the Waco Water Board. S. J. Quay is Superintendent of Water-Works.

Construction of the Metcalf Ave. Sewer, Borough of the Bronx, New York City

By G. L. Christian*

The Metcalf Ave. sewer has a storm-water overflow into the Bronx River, while the dry-weather flow is carried to the White Plains Road sewer. The overflow starts immediately south of Randall Ave. This part is 9 ft. wide by 6 ft. high and 1300 ft. long, and has a capacity of about 355 cu.ft. per sec.; the capacity of the main sewer beyond this point is about 320 cu.ft. per sec.

The sewer is designed to carry the house sewage and dry-weather flow and a small percentage of the storm water; the major portion of the storm water being carried into the Bronx River by means of overflows, thus making it possible to construct a much smaller sewer than would otherwise be possible. The drainage area is 1590 acres.

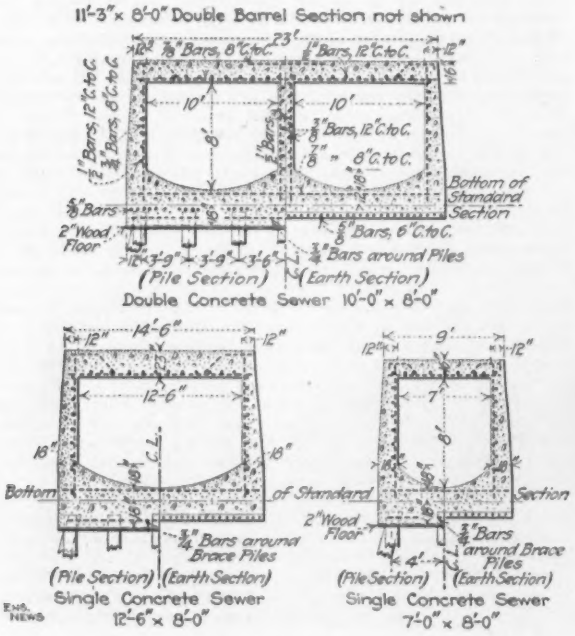

11'-3" x 8'-0" Double Barrel Section not shown
Bottom of Standard Section
(Pile Section)
(Earth Section)
Double Concrete Sewer 10'-0" x 8'-0"
Bottom of Standard Section
Single Concrete Sewer 12'-6" x 8'-0"
Single Concrete Sewer 7'-0" x 8'-0"
ENG. NEWS

Fig. 1. Typical Cross-Sections of the Metcalf Ave. Sewer, Borough of the Bronx, New York City

The new sewer is 1¾ miles long and is constructed of reinforced concrete throughout. The invert is uniformly 18 in. deep, the sides are perpendicular, and the roof flat. The interior height is 8 ft. throughout, the capacity of the sewer being regulated by increasing or decreasing the width. The center walls of the double sewer are all 12 in. thick, and the side walls of both double and single sewers are 18 in. thick at the springing line of the invert and 12 in. thick at the top of the wall.

Spurs are placed at a uniform height of 18 in. above the springing line of the invert and are spaced 12 ft. apart, except at street intersections, where there are none. The spurs enter the sewer at an angle of 60° and have their ends closed by a loose vitrified cover to prevent dirt from entering the sewer, while at the same time permitting ingress of ground water. Wherever they are more than 13 ft. below the grade of the street they are brought up to that height by means of risers incased in concrete.

The manholes are built on the side in single, and in the center in double sewers; in the latter the manholes have an opening, 2 ft. 8 in. in length, left in the center wall directly beneath the manhole opening.

Beginning at the northerly end of the sewer, with a width of 7 ft. and a height of 8 ft., the sewer widens at each street crossing until it attains a maximum width of 12 ft. 6 in. It then changes to two conduits 8 ft. 3 in.x8 ft. in cross-section. From this point it increases in width by steps to allow for the increased flow caused by the connecting lateral sewers until the overflow at Randall Ave. is reached, at which point the sewer consists of two conduits 11 ft. 3 in.x8 ft. in cross-section. South of Randall Ave., the sewer is reduced to a single 11-ft. 3-in.x8-ft. conduit. The excess flow is cared for by the overflow as noted. Fig. 1 shows some typical cross-sections.

Excavation—Over one-half the length of the sewer is built on a pile foundation, the trenches for which it

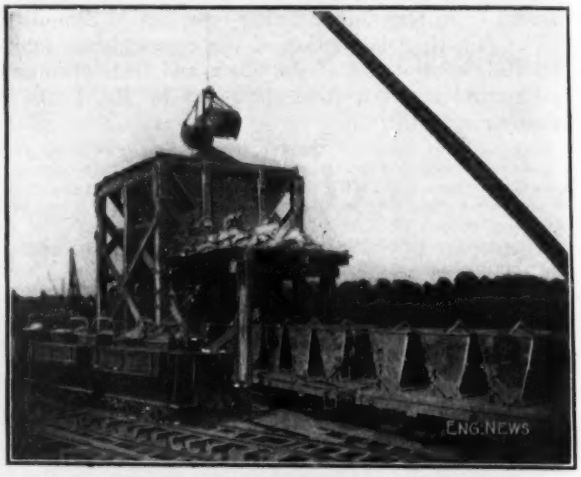


Fig. 2. Loading Buckets with Gravel, Sand and Cement from Hopper at Dock

has generally been found necessary to line with sheet-piling, previous to excavating. The excavation was removed by clam-shell buckets. In the dry earth and rock section the major part of the material was excavated by steam-shovel.

Considerable water has been encountered and it was found necessary to install several steam pumps, with 8-in. suction and 6-in. discharge, as well as steam siphons and pulsometers. An electrically operated centrifugal pump has also been used.

Pile Foundations—In the pile-founded section, some of the piles are as long as 66 ft. below cutoff. The bents are 4 ft. c. to c., the piles in each bent being spaced from 3 ft. to 4 ft. c. to c. Half-way between the bents two batter piles are driven, one on each side of the sewer. The batter piles are securely fastened by a ¾-in. steel bar, which encircles them and is embedded in the concrete surrounding them.

Two steam-hammer piledrivers were used in driving the sheet and foundation piles, the guides for which were hinged near the top to allow them to be swung out of the vertical when driving the batter piles. The

*Assistant Engineer, Bureau of Sewers, Borough of the Bronx, New York City.

piledriver was carried on a platform spanning the trench, which traveled on a track laid with a rail on each side of the trench.

Contractor's Plant

Mixing and Placing Concrete—The contractor's plant for carrying on the work was a large one, and events have proved it to be ably designed and well

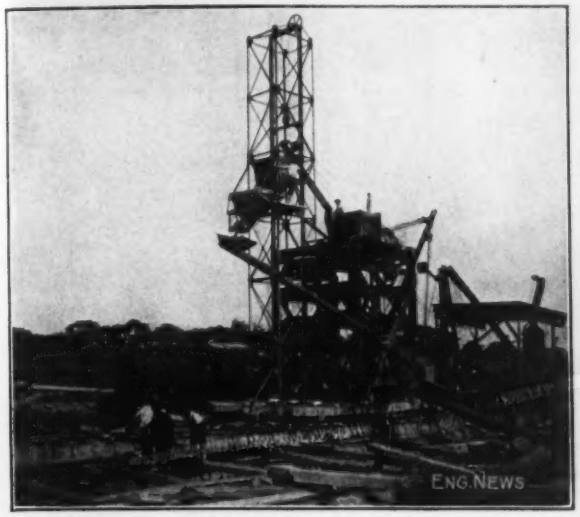


Fig. 3. Concrete Mixer and Concrete Distributing Chutes

fitted for carrying on rapidly and economically a vast amount of work with a minimum of friction. The monthly estimates of work done amounted to as high as $70,000.

At the inception of the work a dock was built at the mouth of the Bronx River adjoining the sewer outlet, upon which was erected and installed sand and gravel bins together with the necessary hoisting plant for unloading piles, steel bars, lumber, etc., and all plant and materials received for use on the different parts of the work.

A 3-ft. gage railway with 57-lb. rails, together with the necessary switches, was laid alongside the work for the whole length of the contract section. Three 18-ton locomotives are constantly engaged in transporting and distributing material along the different parts of the work. The contractor has his own cement boats, scows, etc., the use of which is made to dovetail into the scheme adopted for the mixing and placing of concrete, the net result being a large saving in money when compared with usual methods.

The cement, sand and gravel are handled but once, the *modus operandi* of which is as follows: The sand and gravel bins, together with a cement-storage platform, are located directly above the railway track and are continually fed from the boats by means of a stiff-leg derrick located on the dock. A locomotive drawing two flat-cars (Fig. 2), on each of which are seven bottom-dumping buckets, backs under the bins until the last bucket is under the gravel bin. A measure of gravel is admitted, after which the train is backed until the bucket containing the gravel is under the sand bin and the adjoining bucket is under the gravel bin, when the first bucket receives the required amount of sand while the second bucket is supplied with gravel. The bucket containing the gravel and sand is then backed under the cement platform and four bags of portland cement are emptied into it, each succeeding bucket being filled in the same manner until the fourteen are filled and the train pulls out to be followed by a similar train.

After loading, the train is hauled to whichever one of the concrete mixers happens to be at work. There are two concrete mixers, each of the Hains gravity type and mounted on a timber framework traveling on tracks alongside the trench (Fig. 3). The mixer framework has attached to it a skeleton steel tower 40 ft. high, within which is an elevator consisting of a one-batch bucket operated by a steam hoist located on the first floor of the supporting tower. Beyond this and traveling on the same track is a platform carrying a steam boiler, stiff-leg derrick and a hoisting engine.

The train carrying the fourteen buckets of gravel, sand and cement is run alongside and the buckets emptied one at a time into the upper pan of the mixer. The mixed concrete is emptied from the bottom pan into the bucket at the bottom of the steel elevator. From there the wet concrete is immediately hoisted to the top and automatically tipped and dumped into a hopper, running from which is a chute leading to the forms.

Each batch contains 0.78 cu.yd. of concrete and has at times, for a period covering several hours and with a haul of one-half mile, been deposited at the rate of a batch in 78 sec. Two of these mixers are installed on the work; only one is in use at a time. While the concrete is being deposited by one mixer, the forms are being prepared for concreting at the other, to which the concreting gang is transferred by means of the construction train, at the proper time. The mixers are moved when necessary by one of the locomotives, this operation requiring less than 10 min.

Fig. 4. Forms in Place for Bottom of Invert on a Pile Foundation

The sand and gravel are not moved by hand from the time they leave Cow Bay, Long Island, until they enter the forms as concrete, which requires spreading and spading. The total labor cost of unloading the sand, gravel and cement, transporting them about one mile, and

FIG. 5. REINFORCEMENT IN PLACE FOR LARGE DOUBLE-BARREL SEWER

mixing and depositing the concrete is about 73c. per cu. yd. Wood forms are used throughout. They are made in panels 12 ft. in length and have interior bracing as shown in Fig. 4.

CONCRETING THE PILE SECTION—The tops of the piles are cut to grade and the mud excavated to a sufficient depth to allow 2x4-in. waling pieces to be nailed on the sides of the piles, at right angles to the trench, and with their upper surfaces 14 in. below the pile tops, and a 2-in. flooring is laid thereon; the next step is to tie the batter piles together by fastening a ¾-in. corrugated-steel bar around them (see Fig. 4), after which everything is in readiness for the placing of the Class B (foundation) concrete.

FIG. 6. SEWER INVERT UNDER CONSTRUCTION

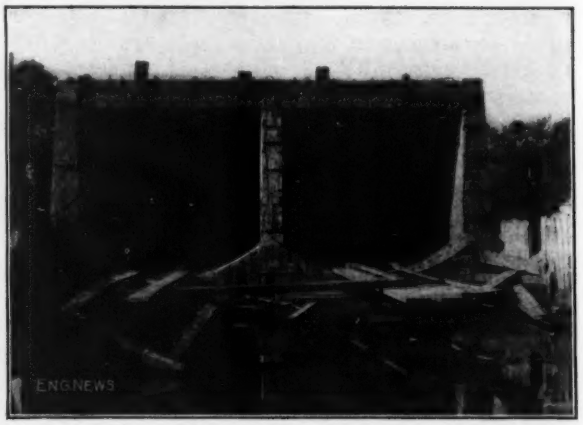


FIG. 7. COMPLETED SECTION OF LARGE SEWER

The concrete is deposited to a depth of 18 in., completely incasing the pile heads and reaching to a height of 6 in. above the tops of the piles. Wooden invert profiles are next set at intervals of 15 ft., after which bars for the side walls and invert are placed.

The concrete is next deposited in alternate sections to within 1 in. of the finished invert surface, after which it is immediately covered with 1 in. of mortar and carefully screeded. After 48 hours the profiles are removed and the remaining sections filled with concrete. V-shaped keys are left at the ends of all unfinished sections and also in the top of the 6-in. section of side wall which forms part of the invert construction. These keys are for the purpose of forming a bond between the old and new work.

The province of the 6-in. wall is to have something against which the side forms may fit snugly, thus producing a good alignment and avoiding leakage of cement below the side forms while placing the concrete in the side walls. The forms for the side walls and roof are next set up, the steel bars for the roof put in place and properly fastened and the side walls and roof concreted in one operation.

In addition to the plant already referred to there are 8 dump cars, 28 four-cu.yd., two-way dump cars, 35 bottom-dumping concrete buckets, and two guy derricks, one being 75 ft. high.

The total cost of the work is about $569,000, and it is being done under the authority and direction of the Hon. Douglas Mathewson, President of the Borough of the Bronx; R. H. Gillespie is Chief Engineer of Sewers and Highways; Josiah H. Fitch, Engineer of Sewers, and the writer is Assistant Engineer, in charge of this piece of work. The contracting firm is Rodgers & Hagerty, Inc., for whom P. W. Rodgers is Superintendent.

The Water Filtration Hold-Up at Ottawa, Ont.

The long-standing water-supply muddle at Ottawa, Ont., bids fair to continue indefinitely unless the law courts again come to the aid of the city. This the courts have been invoked to do in a mandamus suit brought to compel the Ontario Board of Health to approve the latest plans for mechanical filtration of Ottawa River water, as prepared by Hazen & Whipple, of New York City.

Following projects for (1) a gravity supply from the McGregor Lakes in Quebec, (2) slow sand, and (3) mechanical filtration of the Ottawa River supply (all three after plans by Hazen & Whipple, New York City), there comes the Binnie and Houston (London, England) project for a gravity supply from Thirty-one Mile Lake, with its various dams and long steel pipe lines.* The latter was killed first by the courts and then by popular vote, the voters declaring for the Ottawa River supply, filtered.

Under a peculiar act of the Ontario legislature, dated Feb. 21, 1914, Ottawa was directed to secure plans for mechanical filters and to submit the plans to the Provincial Board of Health. If the board approved the plans, the city was authorized to borrow and expend $2,000,000 for their execution, and if the city council failed to pass the necessary by-laws to that end, then the board was authorized to build the works. The act also provided that in case of nonapproval of the plans for mechanical filtration by the board, then the city should at once proceed to carry out the Binnie and Houston plans for the Thirty-one Mile Lake project, with authority to borrow $8,000,000 for the purpose. A further proviso authorized the board to execute this project in case the city authorities failed to.

On Sept. 18, 1914, the Provincial Board of Health of Ontario unanimously disapproved the recently prepared Hazen & Whipple plans for mechanical filters, thus:

> The Ottawa River is beyond any question a polluted source of supply at all points in the vicinity of the City of Ottawa. The character of this pollution was pointed out in the report of Nov. 25, 1911, made by Allen Hazen and others, as well as in other reports of later date made by the said gentleman and others, and all experts agree that the danger of pollution is continually increasing. The fact that it is an interprovincial stream renders the control of its pollution all the more difficult.
>
> The board understands it to be a fact that the people of Ottawa have been led to believe that treatment of the Ottawa River water by mechanical filtration will relieve them of the further use of hypochlorite of lime. In reference to this question, Mr. Hazen, in his statement before the board, said that chlorination would be constantly required and that the use of chlorine as well as the administration of chemicals and control of the plant must at all times be under the most careful and unremitting expert supervision.
>
> While the board is sensible of the value of the chlorination of polluted water as an emergency measure, despite the objectionable taste usually associated with its administration, it feels that it would not be doing its duty to the citizens of Ottawa or to the general public of Canada, who may have occasion to visit the Capital City, by countenancing the use of a water which, after mechanical filtration, constantly requires chlorination, when a pure and adequate supply requiring no treatment whatever may be readily procured.

This action was all the more remarkable because a few years ago the board ordered the city to install a mechanical-filtration plant (plans were made by Hazen & Whipple, but the project was defeated at a popular election in January, 1914); and also because since that date the board has approved plans for mechanical filters ("drifting sand" filters; ENGINEERING NEWS, June 25, 1914) for Toronto.

Under date of Sept. 21, 1914, Allen Hazen wired to Taylor McVeity, Mayor of Ottawa, as follows:

> Rejection of plans by Provincial Board of Health seems to turn on my statements regarding hypochlorite. These statements are used in a way which I consider unwarranted. Under the proposed plan the present objectionable use of hypochlorite would cease. I stated to the Provincial Board that good water would be obtained without hypochlorite but that the use of a small amount, perhaps one tenth that now used, or its equivalent in liquid chlorine or other agent, might be desirable. Such quantity is used in most public water-supplies at the present time from even the best sources, and is unobjectionable. Plans do not differ in this respect from those previously approved by the board and present conditions do not warrant a reversal of former action.

The Thirty-one Mile Lake, or Binnie-Houston project, was approved some time ago by the Provincial Board of Health. In the board's memorandum of Sept. 18, 1914, disapproving the mechanical-filtration project, the Binnie-Houston project was spoken of as "one which provides for a supply of unquestionably pure water from a source and in a manner preëminently satisfactory to the board."

Interesting opposition arguments on the Thirty-one Mile Lake project were presented in a letter "from John Murphy, C.E.," of Toronto, dated Sept. 21, 1914, and sent by Mayor McVeity to the city council of Ottawa:

> Was the Ontario Board of Health's decision regarding Ottawa's Water Supply made with the knowledge of the following facts?
>
> The level of Thirty-One-Mile Lake must be raised 24 ft. before it reaches the top of the divide which now prevents it from flowing toward Ottawa
>
> It will rise to this level, according to Binnie, in 5 or 6 years if 37 in. of rain falls annually. But Ottawa's average rainfall for 40 years is less than 32 in.
>
> Not a single drop of the water which is now in Thirty-One-Mile Lake or of the water that would be in it and the country flooded by it when the level reached the 24-ft. mark above referred to can ever flow to Ottawa. It is only the overflow above this 24-ft. level which can cross the divide and flow toward Ottawa; and yet those who, like the Ontario Board of Health, are bound to force the Thirty-One-Mile Lake scheme on us want the public to believe that all that need be done to get water into Ottawa from Thirty-One-Mile Lake is to tap it with a pipe line.

Even if the court sustains the Provincial Board of Health in its attempt to force Ottawa to go to Thirty-one Mile Lake for a gravity supply, it seems unlikely that the city will be able to finance an $8,000,000 water-supply project for some time to come. A $2,000,000 bond issue for mechanical filters might be taken up locally.

*See "Engineering News," Apr. 9, 1914, pp. 808-9, for review of all the projects, and Nov. 20, 1913, for an account of the Binnie-Houston project.

Field and Office

Concrete-Road Building with Small Concrete Mixers

A rather remarkable record was made during the past summer in concrete-road building in Centralia, Wash., by the use of two very small, cheap, concrete mixers and a force of 16 men.

THE MIXERS—The mixer is known as the "Archer" mixer* and the two units cost a total of only $530. The mixer is of the batch type and consists of a cylindrical drum, on top of which is a small gasoline engine geared direct to the teeth on the outside of the drum. The whole is mounted on a light wheelbarrow-shaped frame, which can be moved by a couple of men. Each mixer has a capacity of 4½ cu.ft. of wet concrete per batch.

METHODS—The road was a two-course concrete pavement 18 ft. wide. The bottom course, 3½ in. thick, was a 1:3:6 gravel concrete and the wearing course, 3½ in. thick, was a 1:2:1 pea gravel concrete.

COST DATA—Fourteen men received $2.50 per day of 8 hr., two men received $3 per day. One mile of concrete road was constructed in 18½ working days. The labor cost was $758.50, or 37c. per cu.yd. of concrete. This does not include the salary of a general foreman, who, in this instance, was the contractor. For the entire 18½ days the average progress was 571 sq.yd. per 8-hr. day. The contractor was J. W. Phifer, of Centralia, Wash.

CONCRETE-ROAD BUILDING, CENTRALIA, WASH., WITH SMALL CONCRETE MIXERS; AVERAGE PROGRESS 571 SQ.YD. PER DAY

Sixteen men were employed—5 men laying concrete (2 spreaders, 2 roaders, 1 finisher), 1 man tending the machines with cement, 1 man tending the machines with water, 2 men loading and wheeling sand, 6 men loading and wheeling gravel, and 1 man delivering cement to both machines.

Temporary spouts, 7 ft. long and swung from a chain extending from the frame of the machine to the discharge end of the spout, were added to the regular equipment of the mixers. This gave the machines sufficient leeway to cover the width of the road, and to reach out over the base to deposit the top course, without any handling of the wet concrete except in spreading.

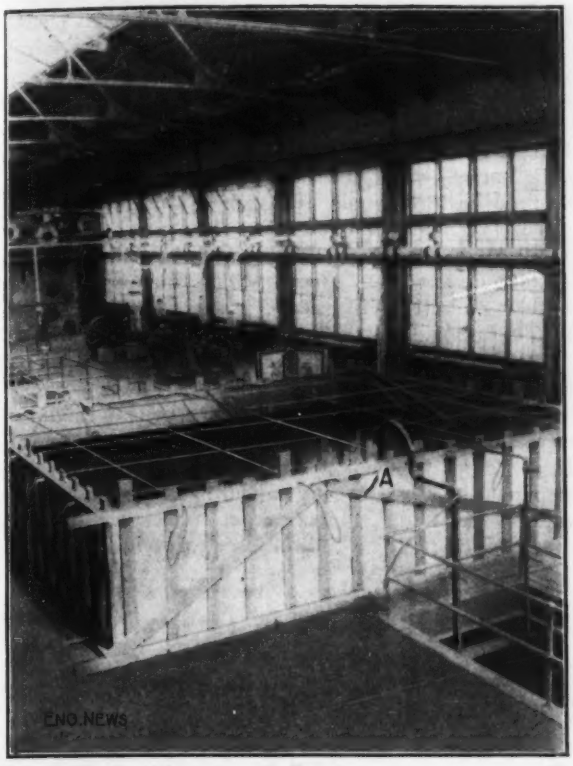
*Made by the Archer Iron Works, Chicago, Ill.

Using Water as Load in a Floor Test

BY F. R. MCMILLAN*

The readers of ENGINEERING NEWS may be interested in the accompanying photograph showing a method of applying a test load to a floor slab of a building. The framework shown consists of 4x4 horizontal timbers with 2x6 verticals bolted every 18 in. Each of the four sides is bolted up into a single section, with swaybracing to prevent sidewise collapse. The opposite sides are tied together top and bottom by light hoisting cables. These pass through the 4x4 horizontal timbers and are secured at the ends by ordinary guy-wire clamps. The lining consists of two sheets, the outer one of plain 13-oz. canvas and the inner one a special rubberized canvas of about the same weight. These sheets are made up square, with eyelets spaced 18 in. on all edges, through which hooks or nails are driven into the verticals of the frame. The corners are made by simply folding one side back on the other.

*Department of Experimental Engineering, University of Minnesota, Minneapolis, Minn.



CANVAS WATER-TANK FOR LOAD TEST OF FLOOR

The view shows the test of a 20x24-ft. panel of the Experimental Engineering Building, College of Engineering, University of Minnesota, where the water was carried to a depth of 4 ft., making a live-load of 250 lb. per sq.ft. This maximum load was kept in place for only a few hours. A depth of 3 ft. was in place for two days, after which it was decreased to 2 ft. and left for 72 days longer. No leaks developed in this length of time, but on removing the load it was found that considerable water had collected between the two sheets and between the outside canvas and the floor.

At the end of the test, the canvas was still in serviceable condition, but would hardly permit of another load as great as 4 ft. For loads up to 175 lb. per square foot and where it is not desired to keep the load long in place, the canvas sheet could be used repeatedly.

At the point marked *A* will be observed a gooseneck of 3-in. pipe, which was used as a siphon to remove the water. The siphon would remove all the water but about 2 in. Near-by will be seen a 1½-in. pipe and valve connecting with the city main, through which the water was supplied.

The water loading proved very convenient in this instance, as it was desired to remove and reapply the load a number of times. While the method presents some disadvantages, such as the impossibility of obtaining extensometer measurements or examining the slab at points on the upper surface within the loaded area, it can be used with great economy under many conditions. The cost of erecting and removing the framework is not great, the big items of expense being the cost of the rubberized canvas (about $1 per sq.yd.) and the depreciation. Where water connections and a satisfactory means of draining the water can be arranged, the test with water costs less than other loading materials. With a meter rate of 60c. per M cu.ft., the cost of the water wasted is only 2c. per ton.

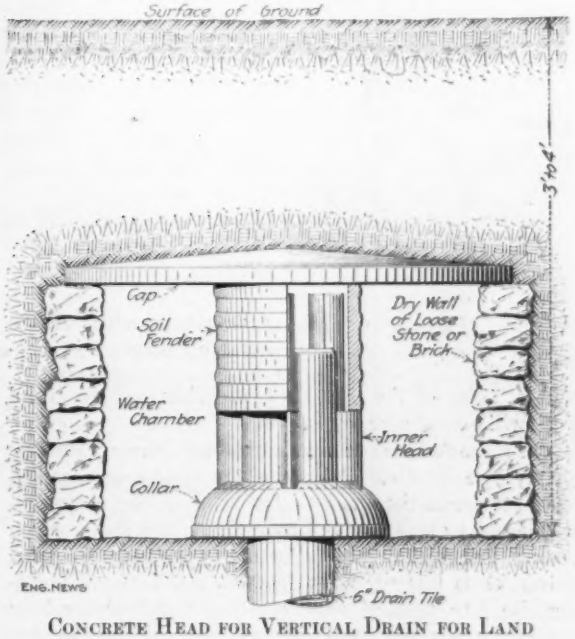
This method was suggested by F. C. Shenehon, Dean of the College of Engineering, University of Minnesota, and was first used in March, 1913.

Draining Land by Wells; Concrete Drain Head

Draining agricultural and swamp lands by wells or vertical drains—instead of by ditches and horizontal lines of tile—has been done successfully in a number of cases throughout the Central states. The wells are sunk to reach underflow strata that will absorb or carry off water readily. Success depends largely upon proper knowledge of the geological conditions, and results are problematical when the drain-wells are sunk at random.

The depth of wells is said to range from 20 to 45 ft. It is claimed that one well will drain from ½ to ¾ acre.

The wells are drilled with augers, pipe extensions being added to the shaft of the auger as the depth increases.



CONCRETE HEAD FOR VERTICAL DRAIN FOR LAND DRAINAGE

Through quicksand or soft clay, casing must be put in. A bucket to remove soft materials and a stone-picker to remove stones or small boulders will also be required. The nature of the materials encountered must be observed carefully. The hole can be inspected by means of a mirror to ascertain the strata reached, etc. The diameter of the hole is usually 8 in., to take a lining of 6-in. drain tile.

The drainage is taken from the soil, surface water being excluded. For this purpose special drain heads are made, which prevent the water from carrying soil into the pipe. A patented concrete drain head, made by the American Drainage Co., Dubuque, Iowa, is sketched herewith. The top of the drain pipe is 3 or 4 ft. below the surface of the ground, and above it the ground is excavated to a diameter of about 3½ ft., the lowest part of this hole

being lined with stones or old brick to form a water chamber. Upon the 6-in. drain pipe is placed a collar, and this supports a grooved inner head surrounded by a sleeve or soil fender. The chamber is roofed with a cap slab. After these parts have been assembled, the ground is filled in above the cap. When the ground becomes wet, the water seeps into the chamber and siphons up under the fender, flowing over the top of the grooved inner head into the vertical drain.

Handling Construction Material by Aerial Tramways

The use of aërial tramways for handling construction material is an interesting feature in the construction of the buildings for the new state penitentiary at Bellefonte, Penn., near the Rockview station of the Bellefonte & Sunbury Branch of the Pennsylvania R.R.. The first building, now being erected, is of reinforced-concrete, 250x60 ft., with three stories for the central portion and one story for the wings. This is located at about the highest point of the site. It is probable that the entire work will extend over several years.

The stone for the concrete is obtained from a limestone quarry ½ mile north of the site, the stone being crushed to ¾-in. size at the quarry. The sand or finer aggregate is obtained by crushing and pulverizing field stone, which is very plentiful in the valley along the railway. The pulverizer is located about 1000 ft. south of the building site. In view of these conditions and of the long period of time which the work will cover, it was decided to use aërial tramways for handling the materials. A plan of the plant is given in Fig. 1. At the building site a storage bin was erected, 16x32 ft., and 16 ft. deep, so divided as to give a capacity for 110 cu.yd. of stone of 55 cu.yd. of sand. Both tramways enter at the top of the structure and dump the materials automatically into the bin. The materials are drawn off through chutes into small cars, which are pushed by hand to the mixer plant. The concrete is handled by an elevator tower and inclined chutes.

The tramways are of two different types. The one for limestone is of the endless type, having a number of traveling buckets which are suspended from trucks running on fixed track ropes and permanently attached to a continuously running traction rope. The carrying capacity is 10 tons per hour with ten buckets of 6-cu.ft. capacity (or 600 lb. of stone), but this will be increased later by attaching additional buckets. There are eight spans, 250 to 460 ft. long.

Of the two parallel track ropes, the one for the loaded buckets is 1⅛ in. diameter, while that for the empty buckets is ⅞ in. The endless traction rope is $\frac{9}{16}$ in. diameter, and its driving pulley at the lower terminal is driven by a 10-hp. engine. A friction clutch provides for stopping the rope without stopping the engine. This rope has a speed of 300 ft. per min. The stone from the crusher is carried by a belt conveyor to a bin of 90-cu.yd.

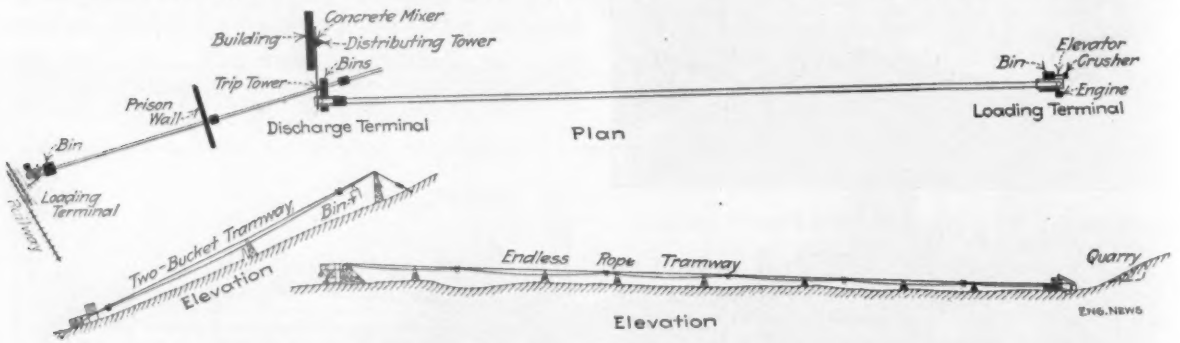


FIG. 1. PLAN AND ELEVATIONS OF AERIAL TRAMWAYS HANDLING MATERIAL FOR A CONCRETING PLANT FOR THE NEW STATE PENITENTIARY AT BELLEFONTE, PENN.

capacity. By means of an automatic loader, shown in Fig. 2, the buckets are filled while in motion and are not detached from the hauling rope.

As the amount of sand to be conveyed is only about half the amount of stone, while the length of haul is considerably less, a two-bucket or alternating tramway was adopted for carrying this material. This tramway has considerable rise and is so arranged that the buckets will clear the wall of the penitentiary if this should be built while the tramway is in service. It has two spans of 350 and 630 ft., with 1⅛- and 1-in. track ropes and a $\frac{9}{16}$-in. traction rope with two buckets of 6-cu.ft. capacity. This rope is driven by a 10-hp. engine and runs at a speed of about 450 ft. per min.

The use of a larger rope on one side is due to the fact that the tramway carries lumber and reinforcing steel,

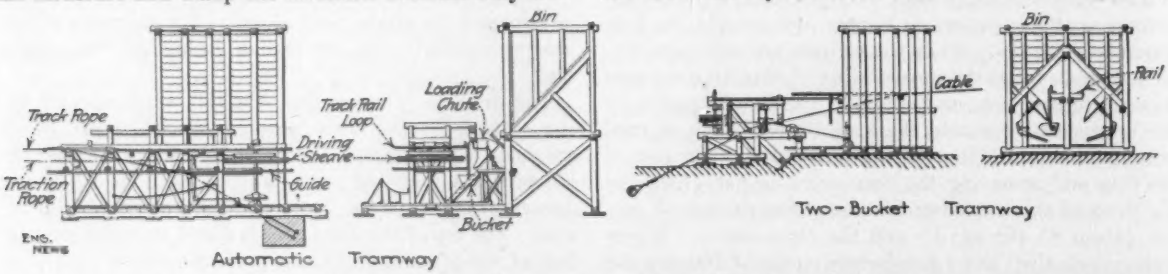


FIG. 2. LOWER OR LOADING TERMINALS OF THE AERIAL TRAMWAYS

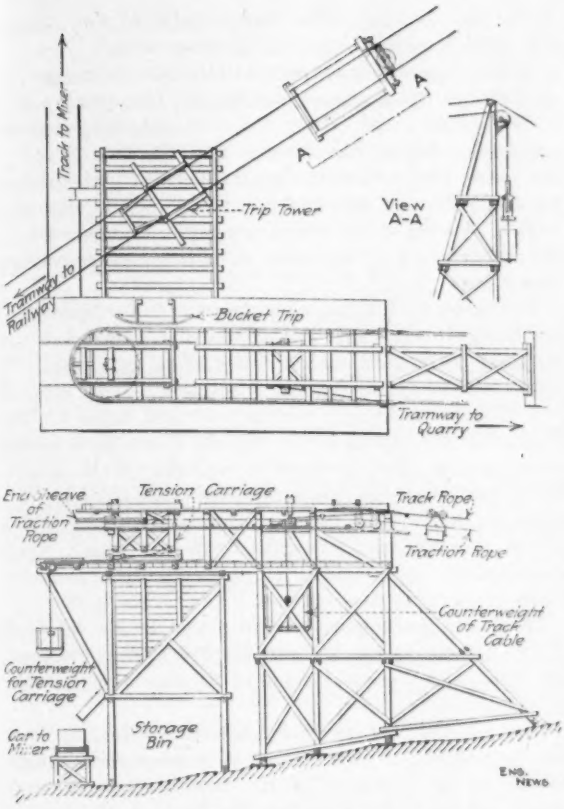


FIG. 3. UPPER OR DISCHARGING TERMINALS OF THE AERIAL TRAMWAYS

and that these materials are handled on this side only, to avoid complications at the terminals. These materials are loaded and unloaded by hand. The sand or pulverized stone is fed by an elevating bucket conveyor to a small bin, from which it is fed to the buckets by special chutes (Fig. 2).

Both tramways discharge automatically into the storage bin near the buildings, and their upper terminals are shown in Fig. 3. The two tramways are used in series for carrying coal from the railway to the quarry. The elevations above sea level are about as follows: Railway siding, 1014 ft.; rail of lower tramway terminal, 1018 ft.; track ropes of both tramways at bin at upper terminal, 1140 ft. (40 ft. above the ground); rail of tramway terminal at quarry, 1029 ft. The ropes of the limestone tramway are at an average height of 20 ft. from the ground.

The tramways, with their bins and loading devices, were built by the A. Leschen & Sons Rope Co., of St. Louis, Mo.

Notes on Errors in Survey Work

BY A. W. BEDELL*

Cumulative errors should always be recognized as such and carefully avoided. Personal errors are often of this kind. To illustrate, the vibration of a plumb-bob string will be compensative, but if a chainman habitually stands so that his eye will project the point of the bob to the ground obliquely, the error from this will be cumulative.

If a chain is out of alignment by an amount d in a length l, the error in distance from this will be

$$e = \frac{d^2}{2l}, \text{ nearly}$$

This error is of little importance on long tapes, but it is cumulative.

It is also worth while to notice that a transit should be centered more carefully in one direction than in another (see ENGINEERING NEWS, Jan. 22, 1914, p. 195).

Very often it is required to know what error of closure is to be expected, consistent with the accuracy of the work done. The usual way of designating errors of closure, as 1:3000, etc., is misleading, for the degree of error does not bear a constant relation to the distance. The same accuracy of work which would produce an error of 1 ft. in 3000 ft. would result in an error of $\sqrt{2}$ in measuring 6000 ft., which is 1.4 ft. in 3000 ft.

Since most errors vary with the square root of the distance and since areas vary with the square of the distance, the closing error may be expected to increase with the fourth root of the area. But if the work includes many cumulative errors, it will vary more nearly with the square root of the area.

If the angular error in a course AB is represented by a, which results in a distance y at the end of the course, and if x is the error in distance, the resultant of these is the error of closure e. If the course AB were long enough to continue around the traverse and close upon itself, the total value of e would be the error of closure of the survey.

If the probable angular error (in feet) per 100 ft. is taken as y_1, the probable lineal error per 100 ft. as x_1, n as the average length of a course (in 100-ft. chains), m as the number of courses, and l as the total traverse in chains, equal to mn, then for the whole survey

$$y = ny_1\sqrt{m}$$
$$x = x_1\sqrt{mn}$$

and the error of closure

$$e = \sqrt{x^2 + y^2} = \sqrt{lny_1^2 + lx_1^2}$$

On a transit reading to minutes y_1 will be about 0.01 or 0.02, and according to the skill of the chainman, x_1 will be between 0.01 and 0.10. It will be noticed from the first equation that by increasing the number of courses, the error y will decrease somewhat, for it accumulates on a single course, and it is partially compensated as the number of courses is increased—within limits. This formula is applicable only for compensative errors.

When a measurement is made to the nearest unit of any kind, and made accurately, the probable error (from this source) of a single reading is not one division, but a quarter of one division. The greatest error possible would be half a division, and the mean of all errors from zero to a half would be a quarter division. Using large units, therefore, is not inconsistent with accuracy, providing instrumental errors are small.

It may easily be demonstrated that leveling can be done by reading the rod only to tenths, and with 25 sights to the mile, with an error of ¼ of $0.1 \times \sqrt{25} = 1\frac{1}{4}$ tenths. It may be added that for many purposes it is well to use larger divisions, as tenths of feet on rods and

*Chappaqua, N. Y.

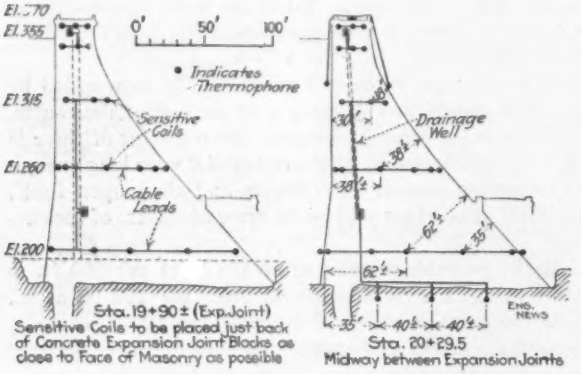
chains, and to subdivide these to hundredths of feet by estimation with the eye only. Those who have never tried this method will be surprised at the accuracy with which work can be done. The average surveyor with ordinary practice can subdivide a unit into tenths with a mean error of about half a tenth or less. The absence of many small graduations is certainly less confusing.

Thermophones in Kensico Dam

By Wilson Fitch Smith*

A number of thermophones have been placed in various positions in Kensico Dam on the new Catskill Aqueduct for New York City for the purpose of determining the variations in temperature in the body of the masonry as an aid to the study of the stresses resulting from the expansion and contraction of the mass due to temperature changes.

In order to obviate the unsightly cracks which occur at irregular intervals in all large continuous masses of masonry the design for Kensico Dam provides for the concentrating of the shrinkage at definite points by the introduction of definite transverse contraction joints at intervals of about 80 ft. This spacing was based upon the observations of a number of continuous dams, but the knowledge of the actual internal conditions at various points in the mass is of particular interest in the further study of this design.



Location of Thermophones at and between Expansion Joints, Kensico Dam

Variation in temperature in a large mass of concrete masonry is of two kinds: first, a sudden rise of many degrees due to the heat given off by the cement in the chemical act of setting, followed by a gradual fall due to the radiation and dissipation of this heat, and secondly, the gradual changes due to the daily and seasonal changes of atmospheric temperature.

The thermophone consists essentially of two coils of fine wire, of metals having different coefficients of electrical conductivity under varying temperatures. In this case, the two coils are of german silver and copper wires and are connected in circuit. The coils are contained in a closed brass tube ½ in. in diameter and 8 in. long. The three connecting wires are No. 16 insulated copper inclosed in a special insulating wrapping and incased in a $\frac{1}{16}$-in. lead covering. The lead covering of the connecting cable is soldered tight to the brass tube.

The thermophones are placed in the dam in two groups, as shown in the accompanying figure. One group is in a vertical plane in the center of a section midway between contraction joints; the other is near the face of one of the joints with a view to showing the result of building up one section of the dam in advance of the adjoining section. Owing to the remarkably rapid progress made in the construction of the dam, no marked difference has been shown.

The cables lead through the masonry to the nearest inspection well and thence to the inspection galleries, where terminal boards and dial switches afford easy means of connection to the indicating instrument. This consists of a Wheatstone bridge, galvanometer and battery. The pointer of the resistance bar on the Wheatstone bridge moves over a scale graduated to read degrees F. so calibrated that when the resistances in the two sides are balanced, as indicated by the galvanometer, the temperature of the thermophone is indicated on the scale. Each thermophone was compared with a standard thermometer before it was placed.

The lower thermophones were placed in the late fall of 1913; those at El. 260 and El. 315 during the present season and those at the top of the dam will probably go in this fall.

It is too early yet to draw complete conclusions from the observations as to the effect of atmospheric changes because of the influence of the new masonry as it is added, but one interesting fact has been clearly demonstrated at several different points in the center of the dam, which is that the setting of the concrete causes a rise of 40° in the mass, the maximum occurring in from 7 to 28 days; the cooler the air the slower the rise in temperature.

This result was most clearly demonstrated in the center of a mass of cyclopean masonry, 80 ft. square with 6 ft. below and 19 ft. above the thermophone, all placed within a period of six days. The concrete is of the proportions of 1:9 with from 25% to 30% large stones in the mass.

*Division Engineer, Southern Aqueduct Department, Board of Water Supply, City of New York, Valhalla, N. Y.

Earth Embankment and Fill at Shopton, Iowa*

The construction of the Keokuk dam, with a consequent rise of the Mississippi River back of the dam, necessitated quite extensive fill work at the Shopton yards and shops of the Atchison, Topeka & Santa Fé Ry., two miles west of Fort Madison, Iowa. The backwater above the dam formed a lake at Fort Madison 1½ mi. wide and 8 ft. deep.

The elevation of the Santa Fé yards was 528. On Jan. 1, 1914, before the final rise in level, the elevation of the river was 522.20. The Mississippi River Power Co. guarantees that the maximum level will not exceed, in flood times, an elevation of 528. It is expected, however, that the normal elevation will be 525. Before the construction of the dam, the elevation was 516 to 518.

The whole work may be divided into the following elements: Grading and riprapping for a new embankment; raising the yard, track and buildings and filling

*Data in this article were furnished by William H. Bush, Engineer-in-Charge, Atchison, Topeka & Santa Fé Ry., Fort Madison, Iowa.

in under and around them; building a concrete retaining wall, 700 ft. up both sides of a creek; re-arranging the sewerage system of the yards; building a $35,000 reading room for employees on an artificial fill of earth with rock shoulder.

The first work to be started, now nearly completed, was building a dike or embankment along the river. The new main tracks are to be built on this embankment,

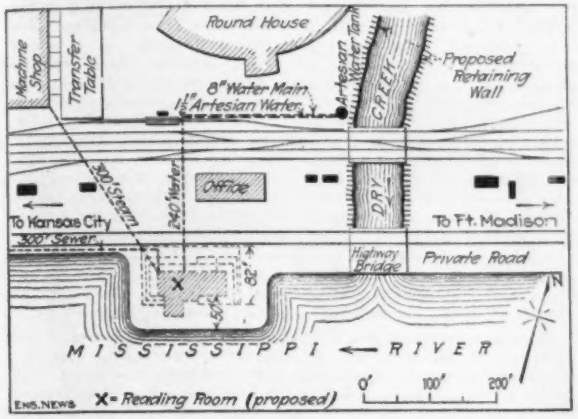


FIG. 1. GENERAL LAYOUT OF MAIN PORTION OF WORK

the present main tracks to be used for switching purposes in yard limits.

GRADING FOR CHANGE OF MAIN LINES

rading for the embankment began on Oct. 23, 1913, and when completed on June 27, 1914, 150,000 cu.yd. had been placed on the south side of the present line, for a distance of 1½ mi. The subgrade is at El. 530.20; base of rail will be 1½ ft. higher. The grading was done by the Mississippi River Power Co., which purchased the land from which to obtain the fill and installed a steam shovel. Earth was moved by a train of 10 cars of 12-cu.yd. capacity each, drawn by a 40-ton locomotive. The average haul was 1 mi., and about 1500 cu.yd. were placed per day. The cost of grading, including the cost of the earth on the land purchased, transportation and placing, coal and engineering, was 28c. per cu.yd.

RIPRAPPING RIVER BANK

Rock for ripprapping is hauled from a quarry at Dumas, 20 mi. west. This part of the work began on May 29, and on July 13 the bank was protected for more than a mile; a month later another mile of bank had been riprapped. Work is progressing eastward. The rock is dumped from cars; the average distance from rail to shoulder is 14 ft. Large pieces are used and the interstices are filled with smaller pieces placed by hand.

In the first part of the ripprapping, only 1 cu.yd. of rock per lin.ft. was required; but opposite Fort Madison as much as 7 cu.yd. was used, the water being 20 ft. deep. About 30,000 cu.yd. of rock were used to protect the bank to the Mississippi River bridge of the Santa Fé, a total distance of 3½ mi. The cost of ripprapping averaged $4 per lin.ft. of bank. L. W. Lewis Sons, Emporia, Kan., was the contractor for the A., T. & S. F. Ry. Co.

RAISING THE BUILDINGS

All buildings, yards and tracks will be raised 3 ft. The general plan is to raise the doors and windows and to raise the floor by filling. In the machine shop the machinery will be raised, concrete foundations placed under them, and sand filled in around. Some of the smaller buildings can be jacked up. The roundhouse and the apprentice building, built in 1912 and 1913 respectively, are above high water. In addition to the yard buildings, there are 20 boathouses along the river front, which will have to be jacked from 4 to 6 ft. and stone foundations put under them.

It is estimated that the raising of the yards and tracks will require 700,000 cu.yd. of earth. This part of the work has not yet been started, but will probably be done by the railway.

HANDLING SEWAGE AND GROUND WATER

The whole work necessitated the rearrangement of the sewerage system. All sewers having outlet to the lake had to be raised, as the flow line was at El. 525. To temporarily handle the sewage from the shops, two 6-in. electric-driven centrifugal pumps were installed and a 6-in. steam-driven emergency pump. These pumps were

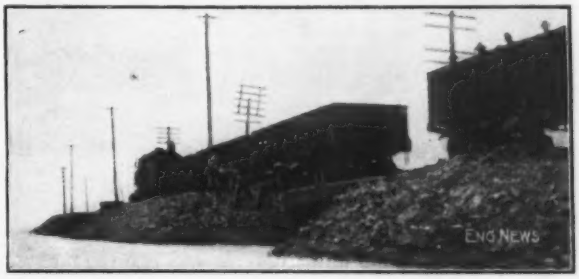


FIG. 2. DUMPING RIPRAP ON EMBANKMENT

placed in a catch basin; one pump operates continuously, the other only when there is a surplus of water in the basin.

The pumping plant in the borrow-pit comprises a 6-in. and a 10-in. electric-driven unit and 10-, 12-, and 18-in.

FIG. 3. RIPRAPPED EARTH EMBANKMENT, SANTA FÉ RY., SHOPTON, IOWA

steam-driven pumps. This plant handles the drainage from an area of about 600 acres, and the sewage from the Prairie Oil & Gas Co. and from a packing-house plant nearby. A dike was constructed around a portion of this area to keep out the backwater. These pumps work automatically, and two men are sufficient to attend to them—one in the day and one at night.

W. H. Bush, who has charge of the whole work, sums up the unfinished items thus:

"The buildings and tracks have not yet been raised; the retaining wall up Dry Creek has not yet been built; the reading room is scheduled for erection this fall; the

main tracks will probably not be changed over on the new embankment until next year. The Mississippi River Power Co. can raise the water to El. 525; but it is doubtful whether this will be done for some time, as there seems to be sufficient water at the present time for the development of 150,000 hp. For the past year the river has been at El. 521.

A Home-Made Mowing Machine for Railway Track

The mowing of grass and weeds along the track is slow and tedious work for the section gangs. The accompanying cut shows a weed-cutting machine rigged up by Gordon Briggs, section foreman on the Chicago Great Western Ry., at McIntire, Iowa.

The blades and operating mechanism of a farm mower were attached to a push car, on which was mounted a 2½-hp. gasoline engine to propel the car and run the mower. The machine can be run at about 4 mi.p.h., and has made 20 mi. with 1 gal. of gasoline. It will cut a strip 6 to 8 ft. wide, and is said to do the work better than hand mowing with scythes. The machine was described by J. T. Frame, formerly Engineer of Maintenance of Way, in "The Maize," published at Chicago by the railway company, to which we are indebted for the photograph.

HOME-MADE WEED-CUTTING MACHINE ON THE CHICAGO GREAT WESTERN RY.

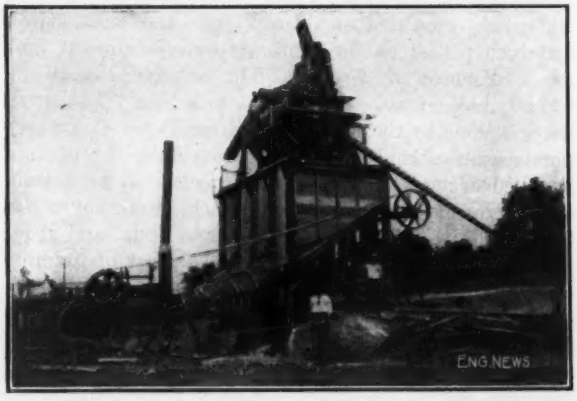
NOTES

Working Drawings on Limp Linen are used for all field work on the new Welland Ship Canal now being built between Lakes Erie and Ontario in Canada. Those drawings which are apt to be needed in the field are printed, brown or black on white, after the so called Vandyke process, on ordinary white linen and are then colored, if desirable, to indicate any peculiar conditions. These linen sheets can then be crumpled into any convenient shape and carried, without much regard to their folding, in pocket or bag. They have proved very useful on account of their long wear, their freedom from creasing, and the ease with which they can be held and studied in wind or rain. When dirty they can be washed and ironed the same as a linen handkerchief. As a rule they are printed in the regular 24x36-in. size. The method was introduced by J. L. Weller, Engineer in charge of the canal.

Developing an Inland Gravel Pit by a Hydraulic Suction Dredge is described by Thomas Sheahan, general contractor, of Hagerstown, Md., in a letter. After commending the articles on the development and operation of sand and gravel deposits, by W. H. Wilms, in "Engineering News," Nov. 5, 12 and 19, Mr. Sheahan writes: "At Sun, La., about 60 miles north of New Orleans, on the New Orleans & Great Northern R.R., there are deposits of gravel in river beds. In this section, along the Bogue Chitto River, the N. O. & G. N. R.R. opened up a large gravel pit for ballast, using a steam shovel. Later, a gravel company took over the development of the deposit, erected a hydraulic suction dredge in the pit and dug a ditch from a nearby stream to float and operate the dredge. The gravel bank then stood about 18 ft. above and extended 20 ft. below the water. The gravel overlies strata of blue mud and is about 60% sand, while 95% is fine enough to pass a 1-in. ring. The dredging outfit consists of a 70x22-ft. hull, an old locomotive boiler, a Morris Machine Co. direct-connected centrifugal pump with about 16-in. suction and 10-in. discharge, three American Hoist & Derrick Co. single-drum reversible hoisting engines for swinging and raising the cutter head, a 4-in. piston pump for priming the centrifugal pump, and a boiler feed-water pump. Pine wood is used for fuel. The crew consists of a chief engineer and two assistants, a fireman and a wood gatherer. The discharge pipe line extends about 400 ft. away from the dredge and rises to an elevation of about 40 ft. above the dredge. The discharge is made into a steel pan, which widens out in a length of 10 ft. to a width of 5 ft., spreading the sand and gravel on a bar screen (¼x1¼-in. bars on edge), with 1¼-in. openings to remove roots, sticks, etc. The material then falls on a series of sloping woven-wire screens and thence into sand or gravel bins, from which railway cars are loaded by gravity. In addition to the dredge crew already noted, three men are required to load cars, four in the screen house, and a boy on top of the discharge pipe, whose duty it is to watch the discharge for clay and signal the dredge when the cutter gets into this material. The means of operation seem particularly efficient and cheap.

Semiportable Sand and Gravel Washing and Screening Plant—The plant shown in the accompanying view has a capacity of 140 to 150 cu.yd. of washed sand and gravel per day, and makes a washed sand which is the undersize of a ¼-in. round hole in the "New Century" screen, having a speed of 20 r.p.m., located on top of the bins. The washed gravel is the oversize of this ¼-in. hole and the undersize of a grizzly or bar screen having 2-in. spaces between the bars. This screen is located between the head of the elevator and the feed hopper of the sand screen. The oversize from the bar screen passes off in the spout, as indicated in the illustration.

The washed sand is elevated by the buckets and discharged into a launder on one side of the tank in which the sand screen revolves. It then passes to a sand box located between the bottom of the screen tank and the top of the bin, from which it is drawn through gates into the sand bin. The washed gravel is discharged from the end of the screen over a dewatering screen, and thence passes to the gravel bin.



SEMIPORTABLE SAND- AND GRAVEL-WASHING AND SCREENING PLANT

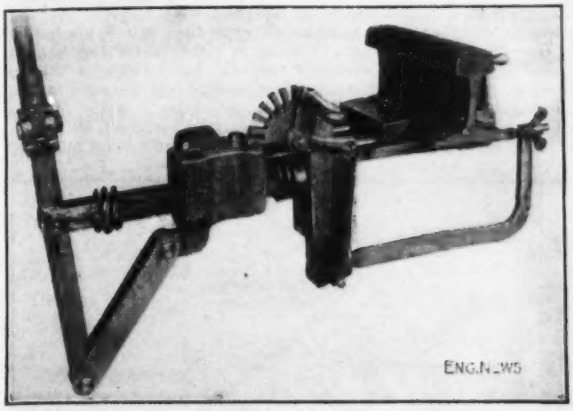
The elevator has 12-in. wide buckets. It is fed by a drag conveyor located in the bottom of the gravel pit, and this drag conveyor has its driving mechanism so arranged that it can be moved in a radius around the boot of the elevator and still be driven from the line shaft on the back of the bins. The drag conveyor is 75 ft. long and consists of boards 6x18x2 in. attached to No. 102½ "Hercules" chain. The speed of the drag conveyor is approximately 100 ft. per min. with the scrapers spaced about 3 ft. apart. The elevator has a speed of approximately 100 ft. per min.

Fresh water is supplied to the screen through the discharge opening by a 1-in. pipe. The dirty water carrying the impurities such as clay and vegetable matter in suspension in the water overflows from the tank of the sand screen and is discharged back into the gravel pit.

A traction engine is used to drive the plant. The original plans called for a motor of 25 hp. The plant described was built by the American Concentrator Co., Springfield, Ohio.

A Portable Rail Saw for Track Work—The special feature of the rail saw shown in the accompanying cut is that it can be used on rails in the track without interfering with traffic, since it makes its cut upward from the base of the rail. It is of the hacksaw type, with a double-acting saw which is given a reciprocating motion by means of the lever at the left. It is intended for steam, electric and street railway work (cutting track rails and third-rail conductors), and can be adapted for cutting structural steel.

The frame lies between the ties, and is clamped to the base of the rail, the clamp being drawn tight by the small



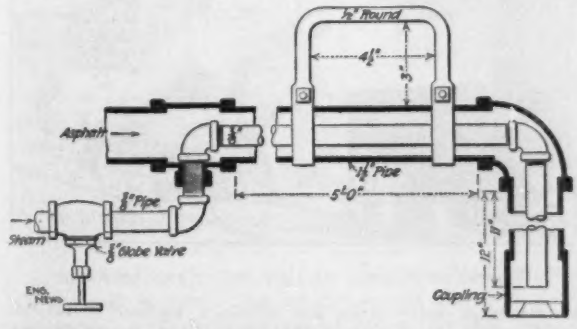
A Portable Hacksaw for Cutting Rails

lever shown at the right of the rail head. At each vertical inch of cut, the saw frame is automatically shifted upward in the end frame, this being effected by the toothed sector. The machine is entirely clear of trains, except when the saw reaches the height of the wheel flanges. Should a train pass at that time, the wheels would simply snap the saw blade. The operating lever is removable, and its socket is pivoted so that if the level should be struck by a car or train it would be simply thrown over parallel with the rail.

The double-acting saw blade used in the machine is of a special (patented) design. Each saw is coated with a special lubricating composition which is softened by the heat developed in cutting the rail, and which is of such a character as not to affect the temper of the steel.

The machine weighs about 100 lb. in the size for cutting rails up to 6 in. deep or 125 lb. for 9-in. rails. The machine, the double-acting saw blade and the lubricating composition are all inventions of Alex Reitlinger, New York, N. Y. The Western agent is J. M. Scheer, 708 Tacoma Building, Chicago.

A Hand Nozzle for Spraying Heavy Asphalts—The accompanying illustration shows the details of a spraying nozzle used on all the asphalt distributing wagons of the Illinois State Highway Department. Steam and compressed air are supplied by a steam road roller or traction engine, used to draw the asphalt tank wagon. The nozzle is attached to the tank wagon by a flexible hose connection and the hot liquid asphalt is forced out under air pressure in the usual way. This type of nozzle is suitable for all grades of asphalts or

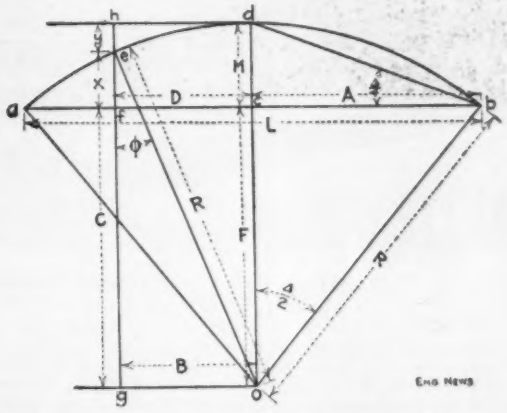


Hand Nozzle for Spraying Asphalt Used by the Illinois State Highway Department

tars. It has been found to be very satisfactory in surface-oiling roads, as the material can be applied in a very fine mist in any quantity desired from ⅛ gal. to 2 gal. per sq.yd. The steam connection near the base of the spray superheats the bituminous material and also breaks it up into a very fine spray as it comes from the nozzle under the air pressure. There are other advantages in this type of nozzle, inasmuch as the high pressure that can be secured will remove surplus dust from the surface of the road and also force the bituminous material into all interstices of the road surface.—[P. C. McArdle, Acting Chief Engineer, Illinois State Highway Department.]

For Sanding Slippery Asphalt Pavements and for sanding bleeding wood-block pavements a machine has been recently put on the market by the Kindling Machinery Co., Milwaukee, Wis. The device consists of an ordinary wagon, hopper-bottomed, the hopper feeding into a fan or spiral bladed sheet-steel disk, which revolves in a horizontal plane a few inches above the pavement. The disk is turned by bevel gears, the driving gear being mounted on a countershaft, which in turn is driven by a chain from the axle of the wagon. The sand is thrown, varying with the speed, a distance of from 20 to 60 ft. A lever operated by the driver controls the feed of the sand. The apparatus is claimed to spread 50,000 sq.yd. per hr. The material may vary from fine sand to 1¼-in. stone, so that the apparatus may be used in road-construction work.

To Find the Offsets to a Curve from the Long Chord—The following may not be an original solution, but I do not recall seeing anything exactly like it, and I find the method I have worked out gives accurate results and is easily handled. Besides giving the tangential offset to a curve at any point whatever, the radius and central angle for any simple curve may be obtained, the midordinate and long chord being given.



To Find the Offsets to a Curve from a Horizontal Chord

Given: The long chord L and the midordinate M of any circle of unknown radius.

To Find: Any vertical offset x at any distance D from the center of the horizontal chord L.

Connect d and b by a straight line, draw og and eg parallel to ab and od, respectively. Connect e and o by a straight line.

From the construction of the figure, od bisects chord L at c.

Call central angle of curve Δ, then angle $dbc = \frac{\Delta}{4}$, then $\tan \frac{\Delta}{4} = \frac{M}{A}$ and Δ is known. The radius, $R = \frac{A}{\sin \frac{\Delta}{2}}$ and $F = R - M$.

Solution 1

In triangle oeg

$$(x + C)^2 = R^2 - B^2$$

then $$x = \sqrt{R^2 - B^2} - C$$

But B = D and C = F.

Substituting we have

$$x = \sqrt{R^2 - D^2} - F$$

Solution 2

In triangle oeg

Solve for angle ϕ $\left(\sin \phi = \frac{B}{R}\right)$

then $$\cos \phi = \frac{(x + C)}{R}$$

$$\therefore x = R \cos \phi - C$$

C = F, and substituting we have

$$x = R \cos \phi - F$$

The tangential offset $y = M - x$.

It will be found that solution 2 is the better, particularly if R and F contain more than four figures, as solution 1 then

becomes cumbersome. It will be found necessary to carry R and F to at least four decimals for accurate results.—[Marriott Price, Engineer, Department of Public Works, Fort Wayne, Ind.]

Care in Handling Paving Brick, to reduce breakage, was displayed by a contractor on recent work at Philadelphia. In loading the bricks from railway cars to wagons, a regular gang was employed and chutes were used to slide the bricks instead of throwing them by hand. In unloading at the street a gang of eight men was employed, two or three in the wagon passing the bricks to the others, who stacked them in piles. The men wore leather guards on their hands. Other contractors on the same work had the drivers and helpers throw the bricks from the cars into the wagons; at the street, the bricks were dumped and boys were hired to stack them.

A Detachable Stone and Gravel Spreader for use on an ordinary dump-wagon is illustrated herewith. This attachment, Fig. 1, consists of an outwardly flaring extension bolted to the rear of the wagon body. To this extension is hinged a series of chutes of telescopic design to permit of adjustment for spreading different depths of material. The free end of each chute rests upon a rail or track which projects to the rear between the chutes, so that the mouth of the chute is

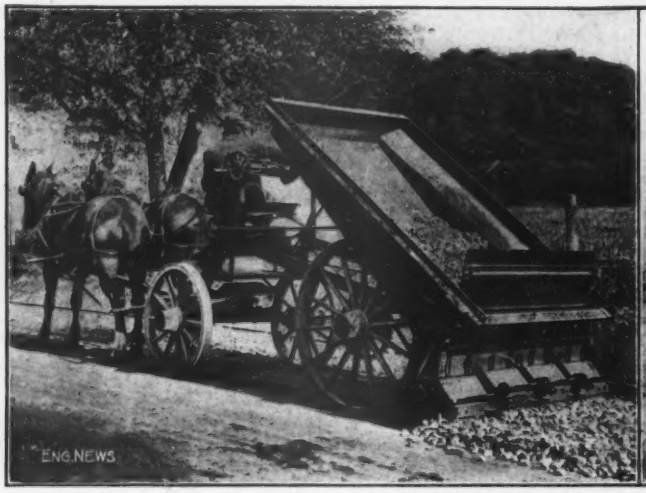


FIG. 1. DETACHABLE STONE AND GRAVEL SPREADER FOR COARSE MATERIAL

maintained at a fixed distance from the ground. A scraper is attached to the rear wall of the discharge opening for leveling off the material. In operation, the front end of the body is elevated by means of a windlass at the rear of the driver's seat. The end gate is then opened, allowing the material to run down and fill the chutes. The team is started and the material is automatically leveled off as the wagon advances. The attachment above described is intended for spreading the coarser grades of crushed stone and gravel at depths ranging from 1½ to 6 in. When it is desired to spread thinner than this, the surfacing attachment illustrated in Fig. 2 is used. This consists of a pair of heads joined by a steel apron and attached to the body so that the steel apron forms an extension of the bottom. Revolving between the heads is a vaned roller which is driven by means of sprockets and gears from the rear wheel of the wagon. The rate of discharge is controlled by the amount the end gate is raised and the feed roller is so located that it blocks the flow of material when the wagon stops. An increase in the speed of the team causes an increased speed of rotation of the feed roller and a consequent increase in the rate of discharge so that the amount distributed per sq.yd. remains practically the same at all speeds. J. Grove Brown, of Groton, N. Y., is the designer and builder of this spreading apparatus.

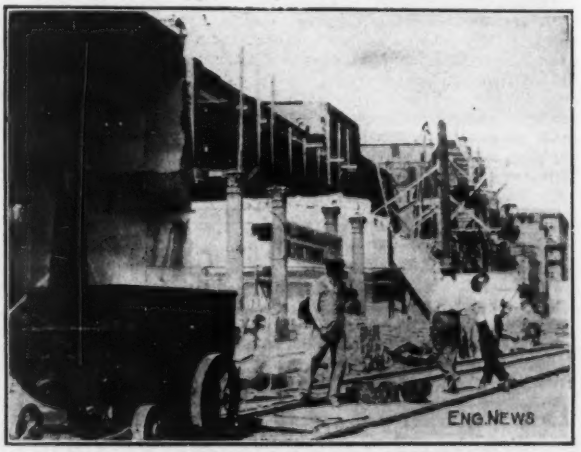
A New Power Tamping Machine, similar to those described in "Engineering News" of May 28, 1914, and Feb. 20, 1913, except that there are three tampers instead of one, has recently been tried in Greensboro, N. C. Each tamping head weighs 100 lb. and falls 20 in. The heads are 8 in. in diameter. The three are in a row on the front of a steel-frame self-propelling gasoline-power truck, having steel wheels. The frame carrying the tampers can be moved sideways to distribute the blows of the head. The machine described was invented by George W. Pritchelt, 805 Ashkow St., Greensboro, N. C., where it has been tried on street work.

Road-Oiling Truck with Interior Pump—Road-oiling apparatus often causes waste of time and oil, due to the necessity of cleaning the pump out with distillate to remove gummed oil of the previous day's work, and running out a barrel or so of oil at the side of the road before starting work to get the nozzles clean and hot. In a new truck used in Pasadena, Calif., these faults have been eliminated by mounting the rotary oil-driving pump inside the tank, where the heat of the oil warms up the pump, and by using a nozzle header that permits a preliminary circulation of hot oil.—[Frank Reed, Los Angeles, Calif.]

A Remarkable Cotton Duck Belt recently made by the Gandy Belting Co., Baltimore, is 712 ft. long, 36 in. wide. The belt weighs 6000 lb. This belt is of the type invented by Maurice Gandy 36 years ago. It is made of heavy-weight cotton duck of special weave, stitched with a heavy sewing cord on machines which make an embedded stitch producing a smooth surface. The stitching is done while the belt is under tension. Both edges of the belt have selvages. After sewing the belt is treated by a special oil process which renders it waterproof and keeps it pliable. Belts of this type have made records of three years' service as sand conveyors, carrying hot sand at temperatures of 250 to 325°.

FIG. 2. SPREADER FOR FINE MATERIAL

Widening Streets in San Antonio, Tex.—Extensive street improvements have been in progress in San Antonio, Tex., for the past year. Commerce St. has been widened by cutting off the faces of some of the buildings and moving back



WIDENING SOUTH ALAMO ST., SAN ANTONIO

by means of screw-jacks and rollers a number of others. South Alamo St. is now being widened, as shown by the accompanying view, taken Oct. 16. As this is a business street, widening in all cases is accomplished by cutting off the fronts of the buildings.

Editorials

The Boston Society of Civil Engineers, like the Cleveland Engineers' Club, has recognized its duty to the public and its members by arranging to give out to the daily press readable accounts of such of its activities as are of general interest. Already the Boston newspapers, like those of Cleveland, have shown their appreciation of this action by devoting liberal space to the "copy" supplied them. Doubtless other local engineering societies will follow the lead of Cleveland and Boston. Why should not the national societies do for the daily press of the whole country what the local societies are doing so well for the press of their own cities?

Rails and Rail Failures in Relation to Train Accidents

It is a matter of deep regret that the unsatisfactory quality of our American rails should be so general—a condition which has so often been made apparent. In fact, our rails, railways and rail mills are commonly criticized abroad on account of the amazing character of some of the steel rails furnished to and accepted by American railways. This condition has been contributed to by the policy of the railways in accepting the rails as made to the makers' ideas and specifications and ignoring the protests and specifications of the railway engineers. Some particulars as to experiences and conditions on individual roads are given elsewhere in this issue.

The railway engineers know what rails should be and how they should act. The position taken by the steel companies has been that they as manufacturers were the best judges of what grade of steel should be used and how rails should be made. This may be so in theory, but it does not work out in practice, and their position is not supported by the character of their product. Doubtless one reason for this is that the operations of the mills are controlled by commercial and not by scientific considerations. Prices also are regulated arbitrarily and have little relation to cost or quality of product. The difficulty in getting manufacturers to deliver good rails has been accentuated by the fact that the railway engineers have not always had the full support of the executive officers of their own roads, there having been a tendency to accept statements of the rail makers' representatives at the latter's own value.

This controversy between the railway engineers and the rail makers is of some years' standing. The engineers' side of the case has been most forcibly presented by the Rail Committee of the American Railway Engineering Association, which for some years past has been compiling very complete statistics of rail failures and has made careful examinations of rails, with results far from complimentary to American rail manufacturers. This committee has sought not only to draft specifications which will result in good rails, but has sought also to secure the adoption and enforcement of these specifications. It must not be thought that the Association has assumed an arbitrary position. On the contrary, it has sought strenuously to secure the harmonious coöperation of the steel interests, its sole object being to secure good rails in the interests of the railways and traveling public.

Taking a position of superior knowledge, however, the rail makers have presented steady opposition to the improvements suggested, requirements made, and specifications prepared by railway or independent engineers. In support of their stand they have argued that the main cause of the numerous breakages in modern rails lies in the heavy wheel-loads and high speeds characteristic of modern main-line service. This argument, however, fails to account for the fact that so many rails on investigation show a defective quality of steel and defective methods of manufacture.

It must be said also that by no means all (or even a large proportion) of the rail breakages occur under the most severe condition of service. It seems evident that the lack of strength of the heavier rail is due not to its size or weight but to the defects of its steel. In fact, it has been rather general experience that defects occur in such heavy modern rails which are not found in older rails of lighter weight, even when both carry the same engines and traffic. On this point the 1914 report of the Rail Committee makes the following deductions:

> (1) The average performance of the heavy sections (85 to 100 lb.) is not so good as that of the lighter sections (72 to 80 lb.).
>
> (2) The wide variation in results must be due to a large extent to a lack of uniformity in the performance of different mills and in the product of any individual mill.
>
> (3) The majority of failures are head failures (such as split or crushed heads) and are due not to imperfect track conditions, but to defective material in the rail.

Appended to this report is a review of the rail-failure statistics, by Robert Trimble, Chief Engineer of Maintenance of Way of the Pennsylvania Lines (Northwest System). Mr. Trimble's review contains the following statements:

> It is evident that the section of the rail as a rule has little influence on the quality of the material. A study of the detail reports makes it clear that other factors in the section are responsible for the difference in performance of different lots of rails. Small differences in chemical composition are not of much importance. Density of traffic, speed and wheel loads are of importance principally as they determine the weight of rail. Probably the majority of rail failures are due to faulty material; that is, segregation, slag inclusion, pipes, etc.

An important indication of the report is the great variation in the rate of rail failures for rails of the same weights and sections under practically uniform conditions of service. On one road, the same section of rail made by two different mills showed 81.5 failures per 10,000 tons for one mill and 124 for the other; in a similar case, the failures were 32.9 and 2.5 for two mills. In a third case, rails of similar section made by three mills showed 35, 186 and 617 failures per 10,000 tons. Mr. Trimble points out that these variations point to the same conclusion that was reached in 1913, namely: "Variations in performance of rails must be attributed to variations in the performance of different mills and also to

variations in the performance of the same mill at different times."

In conclusion, we may state two definite points. In the first place, a small number of accidents caused by broken rails is no evidence of good quality of rails, but is due largely to watchfulness induced by general suspicion of the quality of rails (which suspicion is the result of wide experience). In the second place, a steady improvement in quality of rails is being made, mainly through the united and continued efforts of railway engineers, with some assistance from the steel companies, but in general against the opposition (passive and active) of the companies. Naturally this will result eventually in a reduction of broken rails and accidents due to this cause.

Finally it may be pointed out that while rails of good quality are highly necessary, they are not likely to be obtained under the careless method of simply placing an order and letting the manufacturers decide as to the quality of the material furnished.

The Steam-Boiler Law Proposed by the Mechanical Engineers' Committee

Doubtless the most important subject ever brought before the American Society of Mechanical Engineers is the proposed code for the construction and installation of steam boilers which was laid before the annual meeting in New York City last week. We have referred before to the important work which the committee of the Society is doing in drafting this code.

It would be difficult to find anywhere a precedent for such important work being undertaken by a committee of a technical society purely out of public spirit and without recompense for the time and money spent.

Members of the committee deserve the highest credit for the industry and self-sacrifice they have exhibited in their work on this important matter in the three years since they were appointed, and particularly during the last few months since their work has been under active discussion and criticism by the various interests affected.

Whatever criticism may be made of the committee's work, there can be none of the spirit with which it has pursued its work and with its commendable aim to protect the public safety and bring order out of the present chaos produced by conflicting state legislation on steam-boiler construction.

We believe this situation was generally realized by the members present at the meeting of the Mechanical Engineers last week, and that it was because of respect for the members of the committee and their excellent motives that the committee's report did not receive even more severe criticism.

What happened, briefly stated, was this: The committee presented at the opening business session of the meeting last week the preliminary draft of its progress report, including its rules for the construction and installation of steam boilers, omitting, however, certain laws, tables and forms which have appeared in previous reports and which, it is understood, are to be included in the final report of the committee when completed.

This preliminary draft of a partial report, however, made a book *a quarter of an inch thick;* and it is this which the committee, after amendment, proposes to have recommended to the various state legislatures for enactment into laws to govern the construction and installation of steam boilers.

The committee brought this preliminary draft to the meeting to have it taken up, section by section, and discussed in detail; and this plan was actually carried out. the committee and those particularly interested in the subject meeting day after day, morning, afternoon and evening throughout the whole time of the convention.

It would be difficult to overestimate the value of this discussion, which was participated in by the ablest experts in steam-boiler design in the United States. There is no doubt that the rules which the committee has drafted will be greatly improved as the result of the discussion last week.

A more important matter than details, however, claims attention and received some discussion in the general business meeting of the Society on Wednesday forenoon. This more important matter is the question whether the committee is proceeding on the right course in preparing this voluminous code for enactment into law. So far as it was possible to gage the general sentiment of the members assembled in the Society's business meeting on Wednesday last, we judge the majority of the members would oppose this. In fact, a motion was made which would have had the effect of putting a sudden end to the committee's work; and though the motion was voted down, it received considerable support.

It seems to us that the committee has been led into error, partly through its zealous desire to accomplish a monumental piece of work and partly through the idea that further state legislation on steam boilers must necessarily follow closely such laws as that of Massachusetts, already in force. Actuated by these ideas, the committee has framed a code which comes near being a detailed scientific treatise on the best engineering practice in the design of steam boilers. Valuable and important though such a treatise may be to the engineering profession, it is most unwise to offer such a treatise for enactment as law by a state legislature. Experience has shown, when legislation on technical matters has been enacted, that it has been well nigh impossible to secure its appeal or amendment when the progress of the art renders obsolete matter which was commendable enough at the time it was embodied in law.

If the Mechanical Engineers' Boiler Code Committee desires to secure useful results from the work it has done, it should at once proceed to divide its voluminous report into two parts. The first part, and admittedly the most important, should cover as briefly as possible only those general features of boiler construction, installation and inspection which might reasonably be embodied in law and issued as a guide to boiler inspectors employed by the state or by insurance companies. Nothing of a controversial nature should be included in this portion of the report and nothing which is likely, so far as can be seen, to be subject to material alteration by the progress of the art in the next twenty years at least.

All the rest of the committee's report should be issued after revision as a committee report of the Society, and would have the same standing for the guidance of engineers engaged in the design, construction and operation of steam boilers as has the Society's standard code for steam-boiler tests so long in use.

If the Boiler Code Committee will proceed along these lines, we believe all opposition to its proposed code will disappear, and all interests will unite heartily in furthering its acceptance by the Society, and its embodiment in state legislation.

If, however, the contrary course is followed and the committee offers its entire voluminous report for approval by the Society's Council, by the Society itself and finally for enactment by state legislatures into law, we believe the code will fail of adoption.

Experience has shown that it is a huge mistake to encumber our statute books with all sorts of detailed, minute provisions for the regulation of every industry and business. The damage and injury which the public suffers from such legislation far outweigh any benefits realized. The American Society of Mechanical Engineers has a great responsibility in this matter, as we have before pointed out. Numerous states desire to pass legislation governing the construction of steam boilers and would welcome the intelligent aid of the leading technical society in this field. For this very reason it is of extreme importance that the Society's leadership shall be a wise leadership. The Society has the opportunity to frame legislation which will be conservative, simple and practicable of enforcement, leaving all the multitude of details, involving intricate matters of detail practice, to the members of the engineering profession who are properly responsible for such work. We repeat that no more important matter has ever been presented to the American Society of Mechanical Engineers.

Letters to the Editor

Financing Public Improvements on the Pay-as-You-Go Plan

Sir—I note in your issue of Nov. 26, 1914, a communication from E. P. Goodrich, Consulting Engineer to the Borough of Manhattan, expounding the financial merits of the pay-as-you-go plan as compared with the bond-issue plan for public improvements. The conclusion at which Mr. Goodrich arrives as to the economy of the pay-as-you-go plan has been set before us by various financial experts and efficiency engineers for some time without calling for a great deal of notice. But when an engineer of Mr. Goodrich's standing brings forward the same claims, it moves me to voice a protest against this method of practically lifting ourselves by our bootstraps.

As an example of arithmetic, Mr. Goodrich's arguments are unexceptional. They rest, however, upon an entirely false assumption. The assumption is tacitly made, without any particular attention being called to it, that an improvement year is always of the same value to the community, no matter at what time such improvement year may be enjoyed. The total number of improvement years obtained from the bond-issue plan is compared with the total number of improvement years obtained from the pay-as-you-go plan, and it is of course found that there is a difference arising from interest paid on the bond issue.

The essential falsity of this assumption lies in the fact that an improvement year today is worth more than an improvement year in the future, and that improvement years are not to be taken together in simple summation, but improvement years must be weighted in accordance with the time of their first being enjoyed, much the same as money values are weighted, and money today is worth more than money 25 years from now and the relative value can be obtained by compounding money today or discounting money values 25 years from now to present worth.

Because many if not most of the improvements obtained by the expenditure of public moneys do not return a direct financial profit, this fact is often lost sight of. If, however, a million dollars be spent in erecting, say a municipal office building, and the annual expenses of this office building and interest, etc., amount to, say $100,000, and the office building saved $200,000 in rent money, there is an evident profit in having the office building erected today rather than 10 years from now, and it is easy to see without further argument that the improvement year at the present time is worth more than the improvement year 10 years from now. For such improvements as street paving, no direct financial comparison can be made. It is fair to assume, however, that the improvements would not be made if they did not bring some return, sentimental if not financial, to the public. It is also fair to assume that the return obtained from such improvement is proportionate to the cost. For instance, if the paving in a street is improved today, it may save the public in hauling charges some definite return on the investment which may amount to as much as, or to a considerable amount more than, the fixed charges. This saving to the public is in itself available for further returns to them, and the total gain at the end of 50 years or so must be the compounded value of these various savings.

Speaking in general terms, and no mathematical determination is possible, the value of improvement years increases from the future to the present, and an improvement year is properly to be taken as more valuable at the present than in the future. The value of an improvement year today, taken at the end of 50 years, is to be the compounded value, the rate of compounding depending upon the value of the improvement to the community. On the other hand, the value today of an improvement year at the end of the 50 years is the reduced or present worth of such an improvement taken at this same rate of interest. An improvement year, 50 years from now, of $1,000,000, if improvements are worth only 5% to the community, is today worth only $87,000. What this rate of interest should be depends upon the nature of the im-

provement and its value to the community, and may well be as much as the rate of interest on bond issues, or even very much more than this rate of interest. Whether the total benefit of the improvement to the taxpayers is greater or less by the bond-issue method or by the pay-as-you-go method depends more upon how the money is spent than upon the method of raising the money. If the money be spent for worth-while improvements it is economical to make them today by bond issue. If, on the other hand, the money is spent for extravagant and wasteful improvements, it is better to use the pay-as-you-go method.

This conclusion may be properly reached quite independently of the question of how much money may be worth to the individual taxpayer. If it should be true that money is worth more to the individual taxpayer than the cost to the community as shown by the amount of interest on the bonds, the value of the bond-issue method may be still greater than indicated by the above.

CHARLES B. BUERGER.

170 Broadway, New York City,
Nov. 28, 1914.

Current Meters for Measuring Flow in Pipes

Sir—On account of the discussion in ENGINEERING NEWS, Sept. 3, 1914, p. 510, on the use of current meters for measuring the flow of water in pipes, and in connection with the previous articles there referred to, it may be of interest to mention an earlier instance of a somewhat similar application of a current meter.

I refer to the adaptation of the Haskell current meter to the measurement of flow from artesian wells in Memphis, Tenn., as early as 1890 or 1891. I think the details of the apparatus were the work of E. L. Cooley, then Chief Engineer of the Memphis Artesian Water Co., and that the idea originated with him or with the late Thos. T. Johnston. Mr. Johnston also had an improved current meter constructed for use in the Savannah, Ga., artesian wells in 1897 (and described in the *Journal* of the Western Society of Engineers, 1897, p. 711).

The writer used the Haskell meter for metering some forty wells in Memphis once each month during most of the year 1892. The meter was attached to the end of a line of poles and lowered down the well to a point a few feet below a tunnel connection, which was a special T-casting through which the well discharged into the tunnel system there, conducting the water to a wet well under the pump house. The meter was held centered in the well by means of a framework or basket slightly smaller in diameter than was the inside of the well casing.

The revolutions were ticked off on a counter connected in circuit with the current meter and dry batteries. The rating of the meter was made in a pipe discharging water out through the same kind of a T-casting as used at the tunnel connections, the water passing over a weir for measurement.

H. P. BOARDMAN,
Department of Civil Engineering,
University of Nevada.

Reno, Nev., Nov. 14, 1914.

NOTES AND QUERIES

The three-wheel electric tractor for drawing a street sweeper, illustrated on page 1141 of "Engineering News," Dec. 3, is made by the Clarence L. Smith Co., New York City, instead of the Wirt & Knox Manufacturing Co., of Philadelphia, as stated in the caption under the illustration. The Wirt & Knox Manufacturing Co. is a manufacturer of street-cleaning apparatus only and not of tractors and motor trucks.

William E. Per Lee, of Stillwater, Minn., is desirous of learning the present address of his brother, H. B. Per Lee, who was last heard from at New Orleans, La., June 8, when he was registered at the St. Charles Hotel. He is a civil engineer and his last known place of employment was at Elephant Butte, N. M. Any reader knowing his present address will confer a great favor by communicating it to his mother, who is ill, and his brother.

Pavement Problems and Experience in San Francisco

BY JAMES M. OWENS*

San Francisco may well be called a City of Hills, for almost in its geographical center are located the "Twin Peaks," approximately 925 ft. above sea level, while just to the southwest of them is Mt. Davidson, some 13 ft. higher, and in addition there are a great many minor hills and ridges. It can readily be seen, therefore, that San Francisco presents to the highway engineer many and serious problems.

GRADE PROBLEMS—Some of the grade problems may be better understood by citing a few examples:

In the heart of the business section there is a block with a gradient of 29.8%, paved with cobbles. In one of the most thickly populated residence districts, along one of the main trunk lines leading to the Panama-Pacific Exposition Grounds, we have a double-track electric railway line operated with cable traction helper over a gradient of 26.5%. This street is also paved with cobbles.

In an outlying district a vitrified-brick pavement on a concrete base has recently been constructed on a street whose gradient is 18.1%. This pavement (Fig. 1) is unique in that the brick selected are not of the "hillside" type but of a special, rough, irregular kiln-marked variety. I do not know of another instance where paving brick of this kind has been laid on a city street having such a heavy gradient.

Not far from the Exposition Grounds on Chestnut St., east of Polk St., a block has just been graded, for half of which the gradient is 55.5%.

In the vicinity of the waterfront there is a considerable area of filled-in land, where there is a regular yearly subsidence of about 0.1 ft. Taking care of this settlement and harmonizing the grades in this locality is one of the city's most difficult pavement problems.

ASPHALT PAVEMENTS—One of the largest and best known bituminous limestone deposits in the United States is located not more than 120 miles from San Francisco, and this was developed in the early eighties, and as California is now the largest producer in the Union of crude oil and asphalt, it is not to be wondered at that the majority of this city's paved streets are of these materials.

In the past five years, under the supervision of the

*Assistant City Engineer in charge of Pavement Design, City Hall, San Francisco, Calif.

city engineer, there have been laid in this city about 798,542 sq.yd. of bituminous limestone rock as against 590,617 sq.yd. of other types of asphalt during the same period.

The bituminous rock, as it is found in California, is graded commercially as hard, medium and soft. The nature of these deposits was described and a chemical

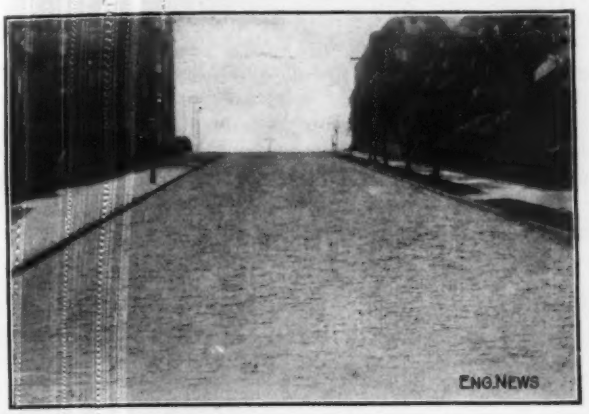


FIG. 1. RESIDENCE STREET ON A STEEP GRADE PAVED WITH SPECIAL BRICK

analysis of the rock given in an article by me in ENGINEERING NEWS, Dec. 22, 1898.

While the majority of our streets have been paved with this material as it came from the mines, without any attempt being made to grade it, of late years far better results have been obtained by proper grading and mixing. The old-fashioned and highly injurious closed steam kettle has been eliminated and the hot-air process substituted in its place.

Probably due to lack of knowledge concerning the nature of the material, a great many of the older pavements have disintegrated and in many cases present a very irregular surface, due to the tendency of the material to creep and form into waves.

Most of the material flowed toward the gutters, because of its excess of oil, its lack of proper bond with the foundation, and the stress of traffic. In some instances the original 2½-in. surface has thinned out to 1 in. at the center and increased to 4 in. at the gutter line. Probably most of this trouble is the result of excessive crowning, which in some of the older pavements was as high as 10%.

On most of the new asphalt pavements a radical departure from the prevailing height of crown was made, the crown being designed quite flat. This has aided in eliminating the tendency of the surface to wave. The entire absence of waves is particularly noticeable in the case of the Geary St. pavement, where some very flat crowns were used.

The paving of the Junipero Serra Boulevard, for its entire length from Ocean Ave. to the county line, is the most important paving work undertaken by the city during the past year. This stretch of roadway is about 1.6 miles long, and is the main route for motor travel from the city to the Peninsula. This work has been done by the City Street Improvement Co. at a cost of $53,340.

The paved portion of the roadway is 25 ft. in width, with 5-ft. rock shoulders on either side. The 3-in. thick concrete gutters are 5 ft. wide and 1 ft. 10 in. deep where they adjoin existing curbs. The pavement foundation is of cement concrete 6 in. thick. The concrete foundation has edgings 6 in. wide and 2½ in. deep so as to inclose the asphalt surface of 2½-in. thickness.

The asphalt surface consists of a 1½-in. close binder course and a 1-in. wearing surface. For the kind of traffic it will have to support this pavement is expected to give entire satisfaction for many years to come.

OTHER PAVEMENTS—New specifications are now being prepared to cover most of the best known of modern pavements, such as creosoted wood block, vitrified paving brick, asphalt, bituminous rock, bituminous concrete and basalt-block pavements.

On account of the excessive gradients on some of our city streets, cobblestone pavement (Fig. 2), if it can be dignified by the name of pavement, is still used, but probably will be replaced by a rough, irregular, kiln-marked brick, which will be far more sightly, practical and durable.

VITRIFIED-BRICK PAVEMENTS—As previously mentioned, these bricks have been used on some of the outlying residence streets where the travel is light and infrequent on account of the grade and only recently on medium heavy traffic streets like 3rd St. and 6th St., where the standard hillside-variety was used. While not down long enough to provide a crucial test, these new brick give every indication that they will be satisfactory. Vitrified-brick pavement is still in its infancy here.

Outside of a few isolated, badly executed attempts made to introduce it formerly, the use of brick in this city practically began with the paving of Powell St. only

FIG. 2. TYPICAL COBBLESTONE ON STEEP GRADE STREET

two years ago. Vitrified brick were laid on one side of the street and vitrified-paving block on the other. Today this pavement presents a remarkably even and good-looking surface and gives every indication that it will last.

BASALT-BLOCK PAVEMENTS—Our basalt-block pavements, used for the heavy traffic streets, correspond to the new granite-block pavements of New York. In fact, the basalt block is a more durable stone and wears more evenly than the Eastern granite. The following is taken from the specifications for basalt blocks:

BASALT BLOCKS—The basalt blocks shall be of the best quality of basalt, not less than 3½ nor more than 4 in. wide; not less than 7 nor more than 9 in. long; not less than 6 nor more than 6½ in. deep. They must be so dressed as to have

substantially rectangular plane surfaces, free from projections or depressions exceeding ¼ in., and such that when two blocks are placed alongside of each other, or end to end, with no part of the space between the blocks less than ⅛ in., the average width of the space between sides or ends will not exceed ½ in.

When laid on a concrete foundation with a 2-in. sand cushion and cement grout or gravel filler, this is one of

FIG. 3. PORTION OF JUNIPERO SERRA BOULEVARD WITH 3-IN. ASPHALT SURFACE

the most durable types of pavement under heavy traffic. The chief objections to its use are its tendency to round on the edges and consequently become slippery and noisy.

WOOD-BLOCK PAVEMENTS—Outside of a small stretch of experimental pavement, laid under the jurisdiction of the Harbor Commission, on the Embarcadero, there are no wood-block pavements in San Francisco. Some will probably be introduced here in the immediate future, however.

CURBS—At the present time there are three kinds of curb in general use in this city, namely, California granite, armored concrete, and California redwood. Until recently, no concrete curb was specified by the city. It

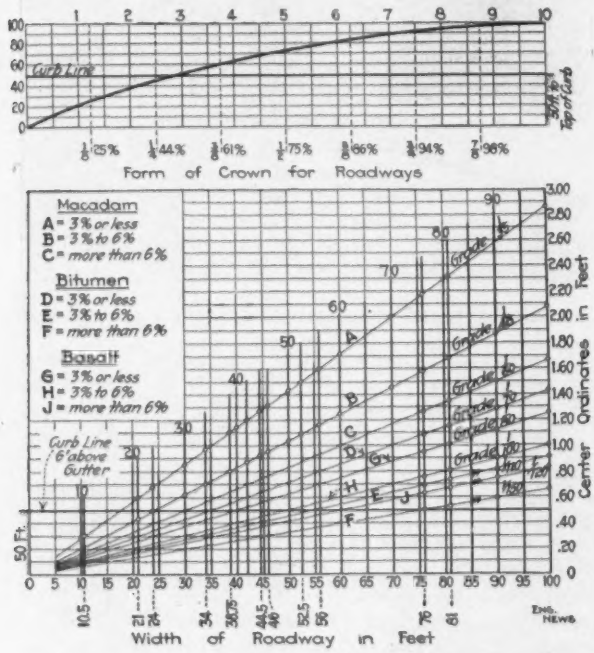


FIG. 4. DIAGRAM OF STREET CROWNS, SAN FRANCISCO, CALIF.

is gradually coming into use, however, and has recently been used to quite a large extent in the rapidly growing suburban districts, and particularly in tracts that have been opened up recently. Its cost is about midway between that of the redwood and the granite. Where sudden grade changes occur with such frequency as they do here, it is apparent that a curb that can be molded to any shape is more adaptable than the more rigid granite curb.

In spite of the heavy toll levied on the pavements of this city by the great fire of 1906, and the few years the city has had in which to recuperate from the catastrophe, street improvements have been carried on at a rapid rate. Much has been accomplished during the interval.

All pavement design and construction are under direction of M. M. O'Shaughnessy, City Engineer.

Pavement Problems; Contrasts of Foreign and American Practice*

BY HENRY WELLES DURHAM†

A most difficult problem confronting the city highway engineer is to make a correct decision on a suitable form of pavement surface—one that shall, if possible, combine the very contradictory qualities asked for by the different interests involved.

THE REQUIREMENTS—Owners of horse-drawn trucks, who are still very influential, desire a surface that will furnish a good foothold for animals in addition to giving light resistance to traffic. The occupants of buildings desire noiselessness and cleanliness. The necessity for access to subsurface structures often requires the easy opening and restoration of the pavement to a condition substantially as good as the original surface.

Further, the taxpayer demands a form of construction that shall combine a minimum of original cost and subsequent maintenance with a maximum of durability; and the general critic calls for the discovery of some hitherto unknown perfect type, and refers us to the great cities of Europe, in which, as he knows from personal observation (during the few hours he spent in each and on the few blocks which he visited), the pavements are perfect, where repairs are never required, where openings are made during the night and restored before morning—all at practically no expense to the taxpayer!

Investigation does not bear out these claims, nor, unfortunately, does it discover the solution of the pavement problem. The municipal highway engineer everywhere abroad, as in this country, is trying to satisfy the same conditions with the same limited success. The best to be said is that general experience has reduced to a very few classes the number of desirable wearing surfaces for city streets; and the selection of the most suitable of these for each particular case is usually arrived at through a process of elimination, by taking the pavement that presents the fewest drawbacks.

EUROPEAN PRACTICE—The original street pavement, and that which is used over more than half the area of

*From a paper "Some Problems of Street Construction and Maintenance at Home and Abroad" read at the American Road Congress, Atlanta, Ga., November, 1914.

†Chief Engineer of Highways, Borough of Manhattan, New York City.

all city streets in Europe at the present time, is some kind of stone block, ranging in quality from the rough cobblestone pavement—which has been generally discarded in New York City, but is still very prevalent abroad—through various grades of squared block to one of hand-dressed blocks with joints of less than ¼ in. and heads absolutely plane, found to a very limited extent in such cities as London, Liverpool and Birmingham and costing from $5 to $10 per sq.yd.

Citizens of none of our leading American cities would be contented to have in a residential street, macadam and stone block to the extent to which they prevail abroad. Consequently, lessons drawn from foreign practice are valueless to us in this respect; while we have already learned to construct stone and asphalt pavements of a quality equal to the best abroad.

The selection of the types of pavement to be adopted in a great city cannot be laid down to a set of rules whose observation will lead to the satisfaction of any community. Local climatic conditions, economically available sources of supply, the relation to each other of the different localities for commerce, manufacture and residence, and, finally, the financial resources of each city all exercise too great an influence to make the practice of one valuable as more than a general example for another.

Advantages of Modern Stone Block—As compared with other types of pavement, in view of its greater life and consequent ultimate economy, modern smooth-dressed, close-fitting, granite-block pavement on a concrete foundation, with joints filled with a bituminous material, has been decided to be most satisfactory for the heaviest traffic streets in the Borough of Manhattan, New York City. Its freedom from slipperiness and ease of maintaining in a clean condition, the small amount of repairs required, and the fact that it is the only surface in which street openings can be restored to a condition equal to the original surface, have been the determining factors, where the general city noises from surface and elevated railroads and other sources render variations in the type of pavement negligible so far as noisiness is concerned.

Advantages of Wood Block—For a fairly heavy and dense traffic in wide streets subject to infrequent cuts and having a level surface or only moderate grades, there is no question but wood pavements can be laid that are eminently satisfactory. They require the most careful attention for maintenance and perhaps vary in quality between greater extremes than any other type.

Nothing finer in the world in pavement surface exists than can be seen in London on the Mall from Admiralty Arch to Buckingham Palace, a street that is subject to a fairly dense pleasure traffic; or on Whitehall, the Strand, Piccadilly or many other adjacent streets in the heart of Westminster. On the other hand, some of the worst wood surfaces encountered in any city can be found within two or three miles of those just referred to, illustrating very clearly the absolute necessity of constant attention to maintenance and the selection of the best kind of wood and workmanship for this type of construction.

Advantages of Sheet Asphalt—For the combination of economy, cleanliness, absence from much noise, and satisfactoriness for the general city traffic in the residential districts, nothing better has been developed than the modern asphalt pavement. It has been adopted on a majority of the streets in New York City. While many miles of inferior pavement of this type have been laid there in the past, these are as rapidly as possible being replaced by a modern type of construction on a concrete foundation, which promises much greater durability and ease of maintenance.

The relatively lesser amount of this kind of surface in European cities is very largely due to the fact that American cities had no good pavements on any but a few streets up to very recently, whereas it has been the practice abroad for many years to construct good macadam surfaces in all residential districts.

At the present time, foreign cities are following our custom of laying sheet asphalt on new light-traffic streets, and in the large real-estate developments around Berlin asphalt was adopted almost exclusively. The cities of Paris and Vienna last year made contracts for extensive repaving with asphalt, which is being substituted in Vienna for the old stone surfacing of the Boulevard; while Paris is tearing out many miles of stone block, inferior wood and macadam and relaying with asphalt.

Need of Closer Supervision and Inspection—It would seem as if some of our city engineers thought that the whole aim of their office had been obtained when they had succeeded, down to the last period, in describing chemical and physical qualities of the materials to be used and the exact details to be followed; just as we Americans have too great a tendency to regard our record file and office systems as ultimate ends. The specifications used in such important cities as London, Birmingham, Liverpool, Hamburg and Berlin, and even Paris, where the most attention is given to detail of any city in Europe, seem noticeably weak in contrast to ours and to leave much to the honesty of the contractor. But when it comes to the execution of the work the attitudes are reversed, and the European engineer and contractor seem to work in harmony with but one end in view, namely, the construction of the particular piece of work called for at the price agreed upon.

A recognition of the difference of national traits furnishes no indication of how to change them, except in pointing out the direction in which almost all of our cities can obtain better work—that is, in the line of closer inspection of materials and workmanship of construction. It is a problem that is worthy of the attention of many men who may have a tendency to regard anything but the scientific end of engineering construction as beneath their dignity.

Conclusions—In concluding, the fact must be emphasized that the most satisfactory type of wearing surface is largely a local question. New York lays wood-block pavements only on level streets, Berlin only on grades. Other forms of block pavement than those largely used in New York City are giving satisfaction elsewhere. Many successful brick pavements and those of various types of bituminous concrete are laid in neighboring cities. The question of paving construction in and adjacent to the tracks of street railways is a problem by itself.

One point above all must be kept in mind—careful work for a short time will lay a good pavement; but it can be kept in its place in good condition for use only by constant vigilance. A thorough organization, for the purpose of inspecting and reporting defects and for the execution of immediate repairs, is the prime requisite of a good highway bureau.

The Palmer Memorial Stadium at Princeton University

SYNOPSIS—Details of design and construction of the largest reinforced-concrete stadium, seating normally 41,000 people. Simple design consisting of transverse inclined girders on columns and carrying continuous slab of seats.

Some weeks ago ENGINEERING NEWS devoted considerable space to the description of the so called Yale Bowl, the new amphitheater just completed at New Haven for the football contests of Yale University. Practically contemporaneously with the Yale Bowl there was completed at Princeton University, Princeton, N. J., a reinforced-concrete stadium for the same purpose, which, while somewhat smaller in capacity than the Yale structure, is the largest reinforced-concrete grandstand or stadium in existence.

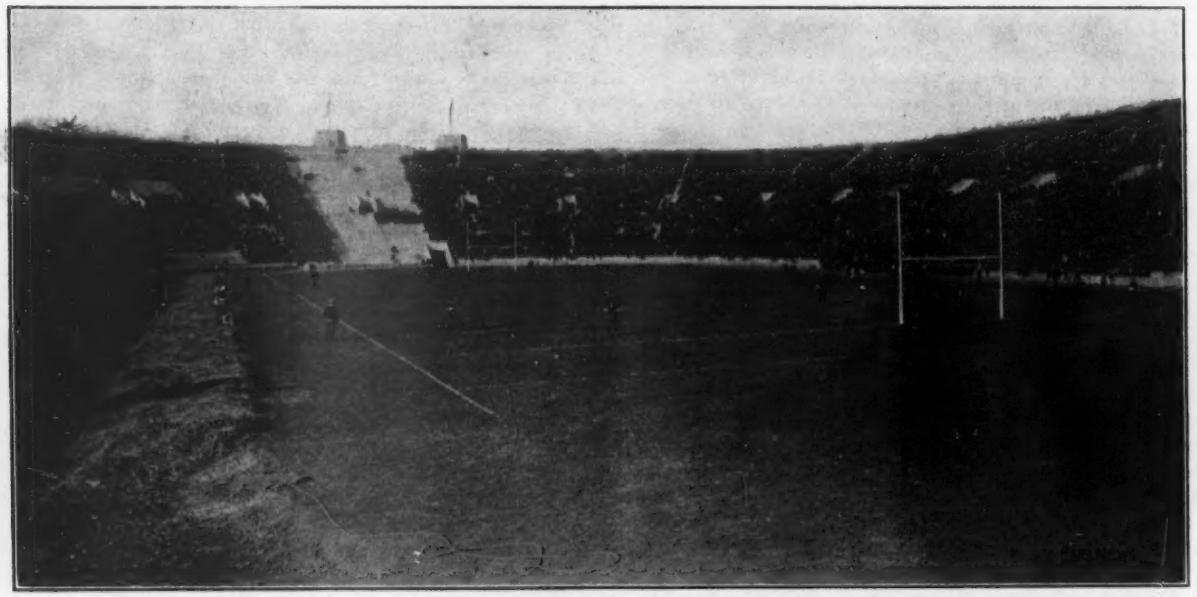


FIG. 1. THE PALMER MEMORIAL STADIUM AT PRINCETON UNIVERSITY, PRINCETON, N. J., AT THE YALE-PRINCETON GAME, NOV. 14, 1914

The Yale Bowl is an elliptical amphitheater of earthwork, paved on the inside with reinforced-concrete seats, and having a normal seating capacity of 61,000, although at the Yale-Harvard game of Nov. 21, 1914, there were nearly 69,000 persons present, the extra 8000 being provided for by seats on the upper walkway. The Princeton stadium, on the other hand, is entirely of reinforced concrete. It is U-shaped, as is the Harvard stadium, which was completed in 1905 (ENGINEERING NEWS, Apr. 27, 1905, p. 434), and it seats 41,000 persons as compared with 25,000 for the Harvard stadium, the next largest reinforced-concrete structure of this sort. Construction on it was going on all during the past summer and the field which it surrounds was used for two games this fall, the Princeton-Dartmouth game of Oct. 24 and the Princeton-Yale game of Nov. 14. At neither of these games were the seats completely filled.

The Princeton stadium was presented to Princeton University by Edgar Palmer, Class of 1903, in memory of his father, who was a graduate of Princeton College. It cost approximately $300,000. The architectural design was made by H. J. Hardenbergh, architect, New York City, the structural design by Purdy & Henderson, consulting engineers, New York City, and the contract was carried out completely by George A. Fuller Co., also of New York City.

Fig. 2 gives a half plan of the stadium, a section through it showing the structural design and a partial longitudinal section. From that drawing the general nature of the structure may be understood. It is horseshoe-shaped, the total length being 652 ft., and its total width 520 ft., both dimensions out to out of all concrete. The seats are in the usual bank, 72 ft. high at the highest point, and extend on tangents parallel to both sides of the playing field for a distance of 454 ft., at the closed end being connected by a variable-radius curve which brings the nearest seat at the crown of the curve as near as is artistically consistent to the goal posts located at that end of the field.

The entrance, at the outside crown of the curve, is made particularly pleasing from an architectural standpoint, as is shown in the view in Fig. 4. Through this entrance the playing teams enter the field. The stand itself is entered from 26 runways, which incline up from the outside ground level to entrance into the stands about half-way up their slope. The whole stadium is surrounded by a high iron picket fence to control ticket taking.

STRUCTURAL DESIGN

The structure is very simple. Reinforced-concrete columns, founded on simple spread footings, were spaced

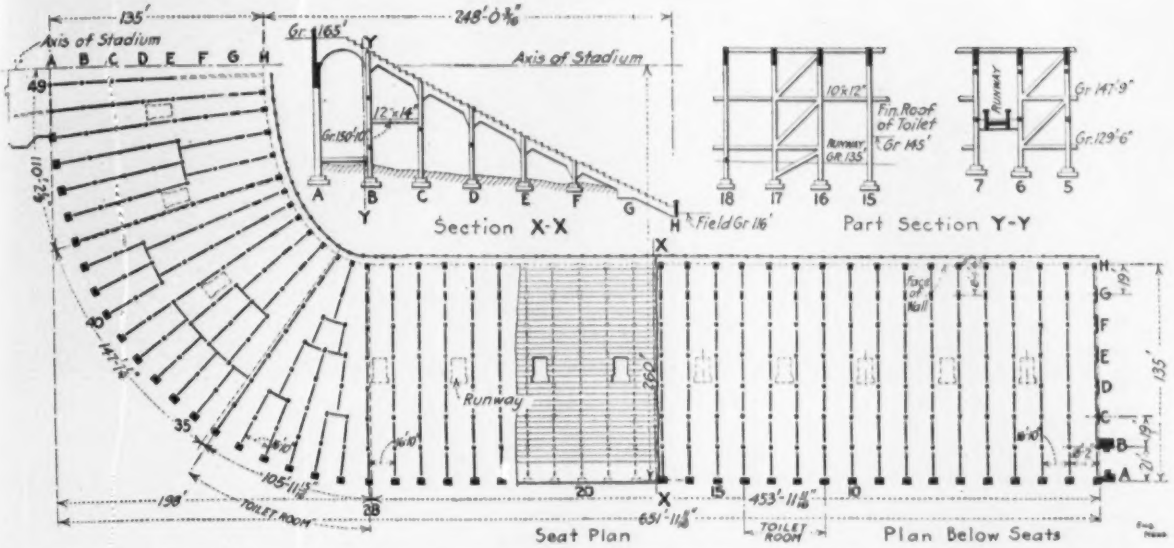


FIG. 2. HALF PLAN AND DETAILS OF REINFORCED-CONCRETE STADIUM AT PRINCETON UNIVERSITY

uniformly 16 ft. 10 in. longitudinally and 19 ft. transversely on the two straight sides of the stand and on approximately the same dimensions but on radial lines in the curved part. The transverse line of columns carries inclined girders which are notched on their top surface to the step shape. Spanning these girders, the steps themselves were cast as a continuous floor clear around the structure. There are no expansion joints, but special reinforcing was placed in the so called riser beams, that is, the steps, to take up any expansion and contraction.

The columns, except for the rear line, are 16x16 in. square, reinforced with straight rods tied together every 12 in. with ¼-in. wire. The two front lines of columns are so short as not to require regular column design, but are in effect mere pedestals. The columns in the rear line are each 4 ft. by 5 ft., and each has a recess on the inside face, as shown in the view in Fig. 5. Columns are braced by occasional horizontal beams in both directions and by longitudinal diagonals in the higher bents.

The girders are each 10 in. thick and vary in depth with the jogs in the steps. At the higher end the girders are formed into an arch which spans the 21-ft. opening, which is used for the promenade leading to the various runways. This arch carries on its forward half the last four

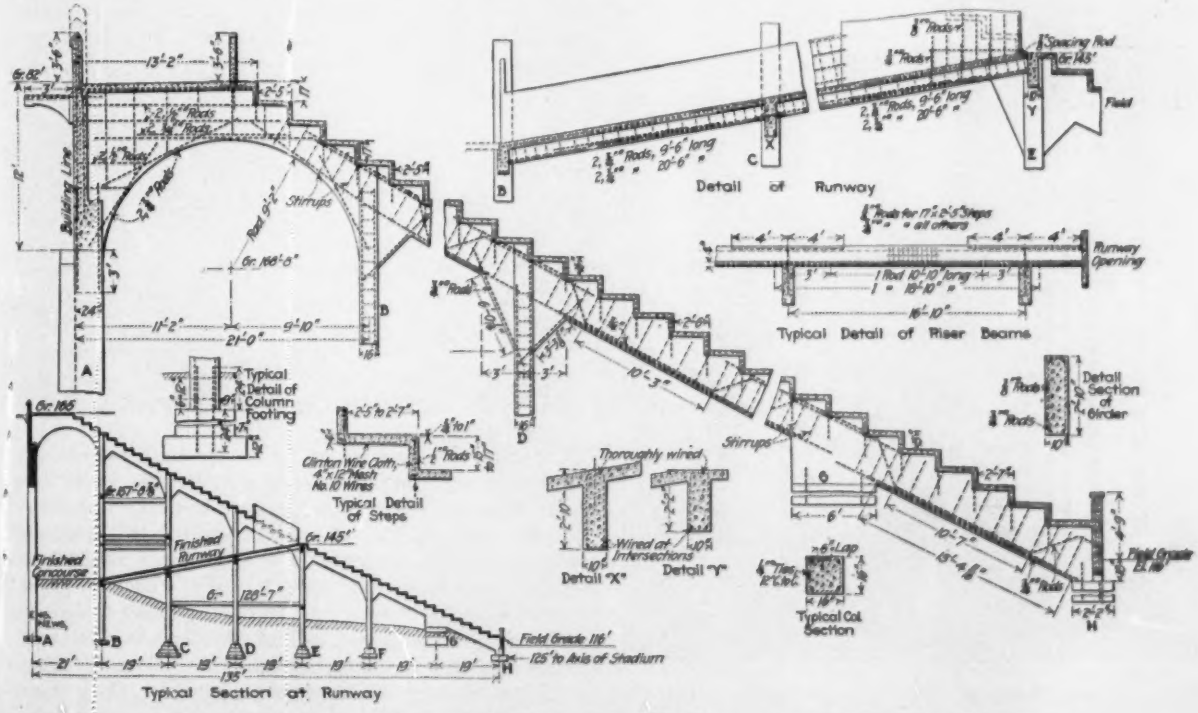


FIG. 3. DETAILS OF REINFORCED-CONCRETE MEMBERS OF THE PRINCETON STADIUM

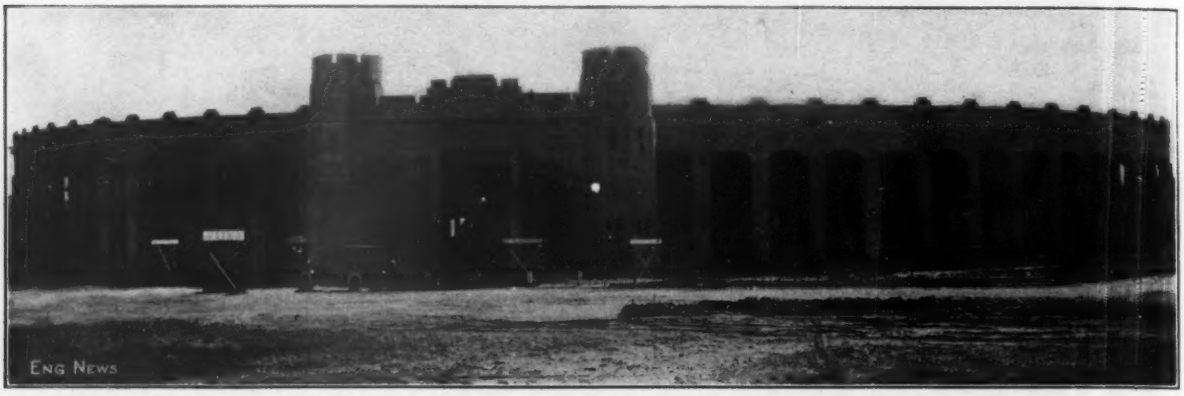


FIG. 4. THE ENTRANCE TO THE PRINCETON STADIUM

steps of the stand and on its rear half a walkway used as a general concourse for walks before, during and after the game. This walk is protected on each side by a reinforced-concrete railing. The view in Fig. 5 shows the remarkably fine effect which this arcade presents to one passing beneath.

The line of the steps is not straight from top to bottom, but has a slight dip downward at the middle. This curve was worked out by experiments so as to permit each row of spectators to see the field to best advantage. In forming this curve the steps vary from 15 to 17 in. in rise and 2 ft. 5 in. to 2 ft. 7 in. in tread. They are reinforced by wire cloth continuous from bottom to top and by continuous longitudinal rods at each junction of riser and tread. The riser beams are further anchored to the girders by vertical rods 3 ft. long, penetrating both girder and riser. Up to the present the bare concrete steps have been used for seats but it is intended to put a 12-in. planed board seat along the front of each concrete step. The concrete steps, it will be noted, are wide enough to permit such a board to be used as a seat at the front end of the steps and to leave sufficient space at the rear end for a walk on each row.

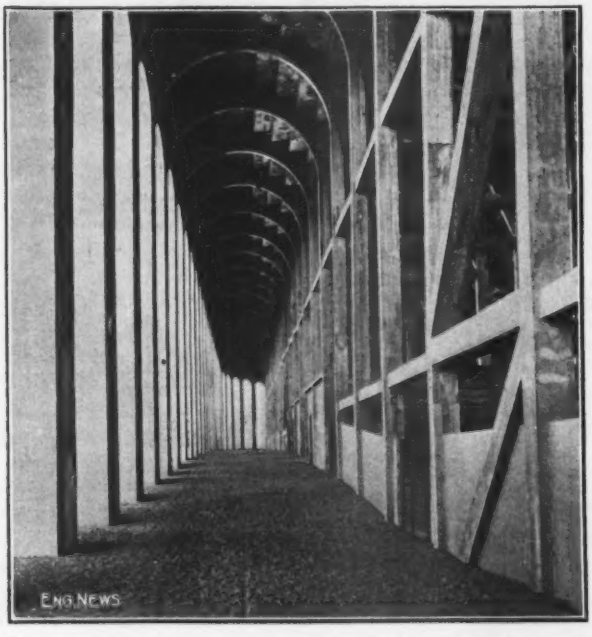


FIG. 5. VIEW THROUGH PROMENADE ARCADE AT REAR OF PRINCETON STADIUM

The runways, spaced every third row of columns, are inclined slabs running up from a so-called concourse or walkway between columns *A* and *B* to the top of the stand at column *E*. They rest on transverse girders spanning between the columns and are protected by a solid reinforced-concrete railing. Inasmuch as the elevation of the concourse varies and the level of the runway openings at column *E* is constant, the slope of the runways varies from 1⅛ in. to 2¼ in. per ft. At the first four runways from either end of the U, steps at the bottom were used in order to keep the slope within the above limits.

The foundation conditions at the site were good. Piles were not necessary. The columns have simple footings placed usually 3½ ft. below ground surface, i.e., below frost depth. A few of them rest on shaly rock, while the others are on sand and gravel. A low soil pressure, 3 tons per sq.ft., was adopted in order to be safe in case variable material were encountered.

CONSTRUCTION

Work was started on the excavation for the stadium Apr. 17, 1914; forms for the concrete work were started May 19, and the field was opened for its first game on Oct. 24. The leveling of the field was the first operation. This was done by steam shovels and carts, 40,000 cu.yd. of earth being moved in this manner. After it was brought down to a level, a 30-in. playing field was made of successive layers of broken stone, cinders and turf, with open-joint drain pipes along the bottom. New turf was placed with considerable success. The playing field for the two games this year was quite up to expectations.

Concreting was carried on by two separate gangs, each a complete organization, beginning at the two open ends of the stand. These two gangs were worked one against the other and by the competition considerable progress was made. The concreting was done by chuting from towers which were about 160 ft. high. Each of these towers had to be moved once. In the beginning they were placed along the side and back of the stand, so that with the use of extensive stepped troughs (Figs. 6 and 7), they could control about two-thirds of the straight side. When this had been concreted, they were moved up to near the

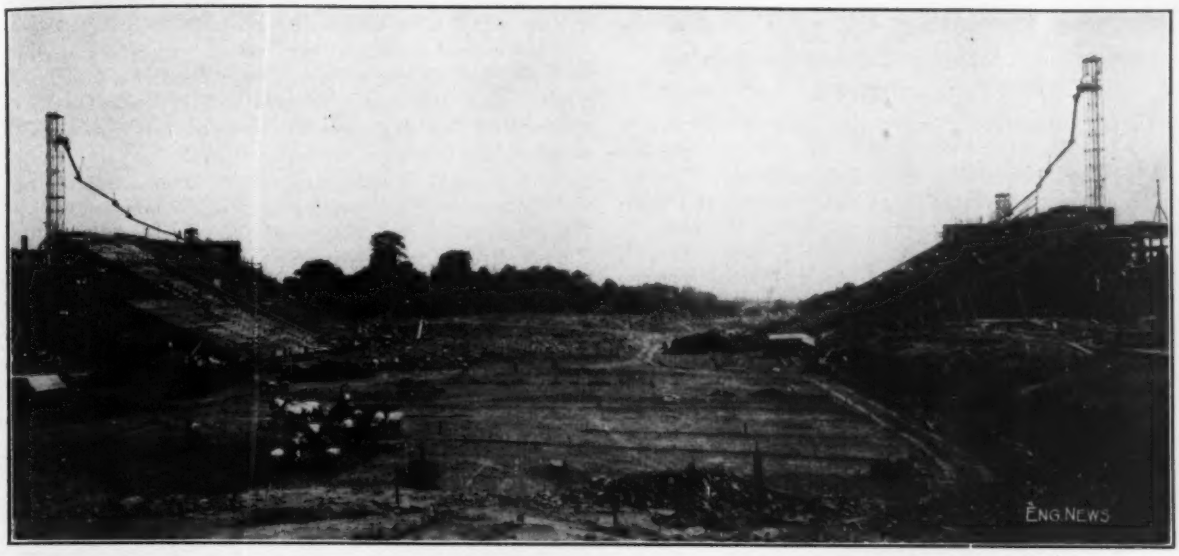


FIG. 6. THE PRINCETON STADIUM DURING CONSTRUCTION

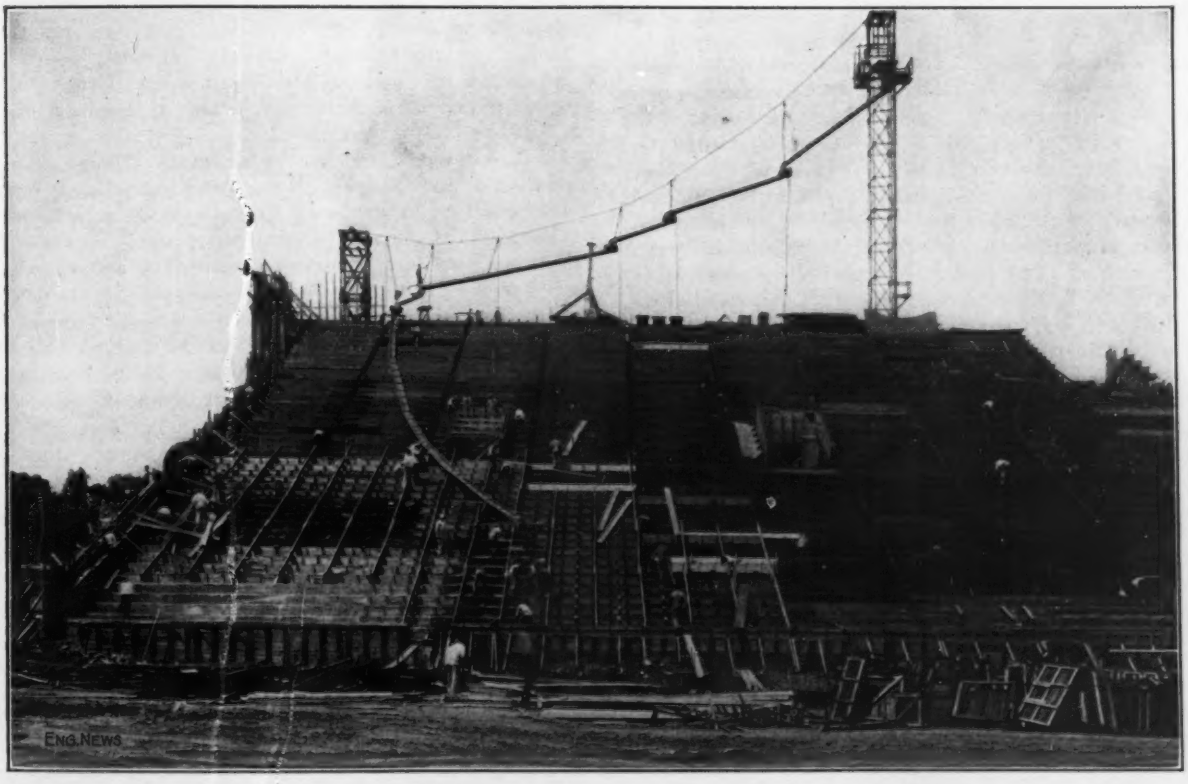


FIG. 7. LONG CHUTING OF CONCRETE FOR LOWER SECTION OF DECK, PRINCETON STADIUM

point of curvature and controlled the remaining part of the straight and half of the curved part of the stand. On account of the great length of trough and the irregularity of the line required a secondary tower was built solely to act as a guy-line tower to support the troughing. It can be seen in Fig. 7.

Mixers at the bottom of these towers were fed by barrows wheeled from the storage piles near-by. All machinery was electrically controlled. The greatest amount of concrete laid with one plant was 227 yd. in 10 hours.

Timber falsework was erected complete for three bays at a time. The falsework was cut at a sawmill on the job and carted to the proper location with horse and wagon. It consisted of straight posts thoroughly braced, carrying at the top the proper boxes for girder and risers. Two sets of three-bay forms were used on each side. Concreting was continuous, so that the first three bays could have been fully moved and in place for the next erection by the time the second three bays of concrete had been laid. Thus the forms were used four times.

Annual Meeting of the American Society of Mechanical Engineers

The 35th annual meeting of the American Society of Mechanical Engineers was held in New York City last week at the Engineering Societies' Building. The attendance was gratifyingly large, 821 members of the society and 542 guests being registered during the week.

At the opening session on Tuesday evening, Dec. 1, the retiring President, James Hartness, President of the Jones & Lamson Machine Co., of Springfield, Vt., gave an address entitled "The Human Element: The Key to Economic Problems." Mr. Hartness presented some of the ideas that were made prominent in his book, "The Human Factor in Works Management," with reference to the importance of recognizing habit as a most important factor in the development of an industrial organization and its personnel. Mr. Hartness also emphasized the idea that for economic production, business must be carried on upon a large scale and held that recent legislation in opposition to monopolies was contrary to the welfare of the nation as a whole.

Tellers then reported the result of the ballot for officers for the ensuing year, which was of unusual interest because of a spirited contest over one of the offices to be filled. This contest brought out an unprecedentedly large vote. Ordinarily, barely a thousand or less of the membership take the trouble to send in their ballots for officers, but this year 2273 ballots were cast. The officers elected without opposition were: President, Dr. John A. Brashear, of Pittsburgh; Vice-Presidents, George W. Dickie, of San Francisco, James E. Sague, of Poughkeepsie, N. Y., and Henry Hess, of Philadelphia; Managers, Chas. T. Main, of Boston, Max Toltz, of St. Paul, and Spencer Miller, of New York City. To fill the unexpired term of the late Alfred Noble as Manager, the regular Nominating Committee named Morris L. Cooke, Director of Public Works, of Philadelphia. An independent nominating committee, made up of over 400 members of the society, nominated George J. Foran, of New York. Mr. Cooke was, however, elected, the tellers reporting 1171 votes cast for him and 859 for Mr. Foran. The reception by the retiring President and President-elect occupied the remainder of the evening.

It would be impossible within the space available to abstract, even in the briefest manner, the twenty-six papers presented at the various sessions on Wednesday, Thursday and Friday, and the discussion upon them. We can merely refer briefly to a few unusual and noteworthy features of the meeting.

First, comes the preliminary report of the Society's committee on a standard code for steam-boiler construction and installation. The discussion of this report occupied practically the entire session on Wednesday morning, and was carried on thereafter as a separate section, working morning, noon and night, until the close of the meeting on Friday. As this code is being prepared for presentation to state legislatures for enactment into law, it is without doubt the most important matter ever brought before the Society; and the careful detail work done by those who faithfully attended these sessions from the beginning to the end of the meeting is deserving of high praise. We have discussed this proposed code further in the editorial columns of this issue.

The second most noteworthy feature of the convention was the special municipal engineering program prepared by the Society's Committee on Public Relations, which occupied the entire day on Thursday. The papers and discussions of this day were not confined to the Society's membership, but were participated in by prominent engineers engaged in municipal service from a number of different cities. The session was made noteworthy by the presence of the Mayor of New York, Hon. John Purroy Mitchel, who delivered the opening address, and also of Andrew Carnegie, whose characteristic Scotch wit was displayed when called upon by the President to address the meeting.

Hon. Henry Bruere, City Chamberlain of New York, discussed the application of the engineering principles to the Police Department, referring to the work of Gen. Bingham in New York City years ago.

Morris L. Cooke, Director of Public Works of Philadelphia, read a paper in which he urged greater public spirit and appreciation of the public interest by engineers in dealing with municipal matters, and appealed to engineering societies for support of measures looking to the increased usefulness of the profession in governmental affairs.

C. E. Drayer, of Cleveland, described the work done by a committee of the Cleveland Engineering Society in promoting greater publicity and public appreciation of the engineer and his work.

At the afternoon session a paper on the "Design and Operation of the Cleveland Municipal Electric Lighting Plant" was read by Frederick W. Ballard, Commissioner in charge of the Cleveland Light Department. This notable experiment in the municipal ownership and operation of public utilities, the largest municipal electric station in the United States, was described in our issue of July 30 last. Mr. Ballard's paper gives, for the first time, particulars as to the engineering design of the station, which involves a number of features of advanced practice introduced with the aim of securing a high economic efficiency. Mr. Ballard also submitted financial figures which on their face indicated that the average price of all current sold by the Cleveland station when it is fully loaded need be only 1.65c. per kilowatt-hour generated in order to pay all fixed charges, operating and maintenance costs, and 8% earnings on the investment besides.

These figures were criticized, however, by Alex. Dow, President of the Detroit Lighting Co., and others in the discussion which followed. It appears that the Cleveland station, which has a total capacity of some 25,000 kw., has thus far secured business enough to utilize less than one-fourth its capacity. It was argued that in order to secure the business essential to its economic operation, a much larger amount will have to be invested in the distribution system than that allowed by Mr. Ballard.

Still another noteworthy feature of the municipal engineering session was the report of the committee appointed at the Snow Removal Conference held in Philadelphia, Apr. 16 last. This committee was made up of J. W. Paxton, of Washington, R. B. Hamilton and Wm. H. Connell, of Philadelphia, and John F. O'Toole, of Pittsburgh. The resolutions and plan recommended by this committee follow quite closely the scheme of organization outlined by J. T. Fetherston, Street Cleaning Commissioner of New York, in his campaign for the

coming winter outlined in ENGINEERING NEWS, of Nov. 26, p. 1095.

Other papers scheduled for this session were: "The Handling of Sewage Sludge," by Geo. F. Webster, of Philadelphia; "Training for Municipal Service in Germany," by Clyde L. King, and "Cleaning Filter Sands," by Sanford L. Thompson.

A noteworthy illustration of the extent to which the American Society of Mechanical Engineers is handling the difficult problem of specialization in engineering work is that on Thursday afternoon there were four different meetings in progress at the same time for the presentation and discussion of professional papers. Besides the general meeting above described, held in the main auditorium, devoted to municipal engineering work, the discussion of the Boiler Code Committee's preliminary report was in progress in another part of the building; a session on the fifth floor listened to three papers on metallurgical topics, and a group of those interested in cement manufacture assembled elsewhere to hear a paper on the electric drive for cement mills.

Of the social events in connection with the meeting the most interesting was the award on Wednesday evening of the John Fritz medal to Prof. John E. Sweet, of Syracuse. Members of the four great national engineering societies coöperated in this meeting, and presentation of the medal was made by the President of the John Fritz Medal Board, Gano Dunn, President of the J. G. White Engineering Corporation. Notable addresses were delivered by Dr. James Douglas, past-President of the American Institute of Mining Engineers, and Dr. F. W. Stratton, Director of the Bureau of Standards.

The spring meeting of the Society is to be held at Buffalo.

The First Convention of City Managers

Few in number but strong in the conviction that they represented the beginning of a new and better era in municipal administration, there met in Springfield, Ohio, Dec. 2 to 4, the first convention of City Managers. Springfield and the manager of that city were given the honor of the first convention because Charles E. Ashburner, the chief executive officer of Springfield since the commission-manager plan went into effect there early this year, is the pioneer City Manager, having begun service at Staunton, Va., a number of years ago.*

As there were only eight City Managers at the Springfield meeting, the convention was largely, and happily, informal. There were a number of commissioners and other city officials in attendance, besides other guests.

FORMAL ORGANIZATION

The new organization christened itself the City Managers' Association. It decided that anyone may be eligible to membership who is the executive head of a municipality, provided he holds that position by appointment of the legislative body of the city. All City Managers present at the Springfield convention and all who responded to the invitation to be present, even though unable to attend, were declared to be charter members—or 13 of the 20 or so City Managers known to have been appointed thus far. The majority of the Managers, it is interesting to note, are civil engineers.*

Officers for 1914-15 were elected as follows: President, Chas. E. Ashburner, Springfield, Ohio, Vice-President, M. H. Hardin, Amarillo, Tex.; Secretary and Treasurer, Ossian A. Carr, Cadillac, Mich.

Dayton, Ohio, was selected as the meeting place for the 1915 convention.

THE TRAINING OF THE CITY MANAGER—The first place on the formal program was given to Henry M. Waite, City Manager of Dayton, Ohio, the largest city which has yet adopted the plan. Mr. Waite said the City Manager plan is the application of business methods to the operation of a city. Although in many cities engineering problems are the most important; yet the City Manager need not be an engineer.

Summing up briefly, the necessary qualification of the City Manager, Mr. Waite said:

> A City Manager should have at least a fair education, with sufficient theory, but not so much as to overbalance practicability.
> He must be an executive.
> He must know how to handle men.
> He must be fair and just.
> He must be firm but polite.
> He must have the courage of his convictions.

Young men desiring to fit themselves to be City Managers should first go into service in their own community. "An ambitious young man, with eyes and ears open, can learn more in a misgoverned city than in a well governed city."

Mr. Waite advised that City Managers who are trying to build up an efficient staff should take the honest, intelligent men already in their employ, who are "anxious to get ahead but who have been hampered by the old order of things, back them up and weed out the weak men."

CITIZENSHIP COÖPERATION—The first City Manager in any city, said Ossian A. Carr, City Manager of Cadillac, Mich., has so much pioneer work to do in bringing order out of chaos that he has particular need of coöperation from the public. This he can get through civic associations and public-spirited individuals. The old-fashioned town meeting may also be of great assistance through the opportunity it affords for discussion and education.

HANDLING PUBLIC-SERVICE CORPORATIONS AND CONTRACTORS—A spirit of fair play and justice to both sides should be observed in dealing with both public-utility companies and contractors for improvements, argued Claude E. Chappell, City Manager of Big Rapids, Mich.

The feeling on the part of the public that lighting and other franchise companies are making exorbitant profits can be met and the companies at the same time be encouraged to reduce rates by a profit-sharing scheme which permits increases in dividends whenever the service rates are lowered.

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*See "Engineering News," July 8, 1909, for an account of the inception and early history of this plan at Staunton.

*The following is a tentative list of cities which had adopted the City Manager plan up to Dec. 1, 1915, with the names of the Managers, so far as yet appointed and known, and with the names of charter members indicated by an asterisk and the names of those in attendance shown by a dagger:

Niagara Falls, N. Y.; Titusville, Penn., H. A. Holstein; Staunton, Va., S. D. Hoisinger; Hickory, N. C., *S. C. Cornwell; Sumter, S. C.; Lakeland, Fla., *D. F. McLeod; Dayton, Ohio, *†Henry M. Waite; Springfield, Ohio, *†Charles E. Ashburner; Big Rapids, Mich., *†Claude E. Chappell; Cadillac, Mich., *†Ossian A. Carr; Jackson, Mich.; Manistee, Mich., *†Charles E. Ruder; Marquette, Mich.; Traverse City, Mich.; River Forest, Ill., *†Karl M. Mitchell; Morris, Minn., *S. A. Siberts, Jr.; Abilene, Kan., *†Kenyon Riddle; Amarillo, Tex., *†M. H. Hardin; Benton, Tex.; Montrose, Colo., *F. W. Pinkerton; Phœnix, Ariz., W. A. Farish; La Grande, Ore., *F. J. Lafky; Inglewood, Calif., Paul E. Kressly.

As to dealing with contractors, Mr. Chappell first called attention to the fact that specifications are so drawn that contractors bid "not upon furnishing a definite amount of labor and material, but upon the temper of the engineer." Then, too, the contractor is "frequently called upon to assume responsibility for both design and construction, although the former may be entirely beyond his control."

Summing up this part of his paper, Mr. Chappell said:

It has been my observation that a contractor is about as honest as the supervision under which he works. If the engineers and inspectors are the soul of honor, the contractor can "put one over on them" only through their ignorance. If they are both honest and competent, they make the rules and he plays the game accordingly.

Much instruction and amusement were afforded by the experiences related by M. H. Hardin, City Manager of Amarillo, a small city on the plains of Texas. Mr. Hardin had been a district-court clerk for twenty years when he was unexpectedly asked to become City Manager of Amarillo. Among other achievements, he has cleaned up the milk supply and collected a large percentage of delinquent taxes. Asked how many commissioners govern Amarillo, Mr. Hardin said: "There are three. It may be that you bigger men can herd more, but it is all I can do to keep three commissioners going in the right direction."

NEWS NOTES

A Fire at Ardsley-on-Hudson, N. Y., on Dec. 6, cost the lives of four persons and destroyed property valued at about $200,000. The fire started in a barber shop.

Nantucket Shoals Lightship Adrift—Lightship No. 65 on Nantucket shoals went adrift when her anchor chains parted under the stress of a northeast gale on Dec. 6. The revenue cutter "Acushnet" left Woods Hole, R. I., to lend assistance. Radio stations along the coast and all steamers were kept informed of the vessel's position by messages sent at frequent intervals by her wireless operators.

Water Flowed Over the Crest of the Scioto River Dam of the water-works of Columbus, Ohio, on Dec. 6 for the first time since June 18. This broke the next to the longest dry spell since the dam was completed, the longest one extending from Aug. 16 to Feb. 10, six or seven years ago. Notwithstanding the heavy rain during the week ending Dec. 5, the rainfall thus far in 1914 totaled only 29.80 in. up to that date, as compared with a normal of 34.64 in.

Ocean Storm Damages New Jersey Coast—A northeast storm, accompanied by high tides, scoured shore bulkheads, pier foundations, and cottage supports on the New Jersey coast, on Dec. 5-6. At Atlantic City a pier was damaged. At Longport and Ventor, near-by, large sections of beach were washed out. The roadbed of the Central R.R. of New Jersey, between Seabright and Highland Beach, was damaged. The wind velocity at Atlantic City was about 30 mi. per hr. At Governor's Island a tide of 7.8 ft. was recorded at noon on Dec. 7; the normal rise is 4.25 ft. It is claimed that this high tide has not been equaled since Oct. 10, 1903. The Long Island shore, especially in the vicinity of Sea Gate, was damaged. Damage to wires of the Delaware, Lackawanna & Western R.R. interfered with communication between Hoboken, N. J., and Scranton, Penn., so that it was necessary to rely on the road's wireless-telegraph system.

The San Francisco Refuse Incinerator at Islais Creek was rejected by the Board of Public Works on Nov. 27, in accordance with the recommendations of the City Engineer, noted on p. 1096 of our issue of Nov. 26. The contractors were ordered to return to the city within 30 days all money paid them on account, and to remove the plant at their own expense.

Coördination of the Various Street Bureaus in New York City is asked by the New York Merchants Association, which has submitted to the Board of Aldermen a project for charter revision with that end in view. The present Bureau of Highways has no jurisdiction over the work of the Department of Water Supply, Gas and Electricity, the Public Service Commission, and other departments and bureaus, which are continually opening the pavements for one reason or another.

November Progress of Rogers Pass Tunnel—The following is the record of heading progress on the Rogers Pass Tunnel of the Canadian Pacific Ry. for November:

East end, center heading,	588 ft.	Schist with some quartzite.
East end, pioneer heading,	529 ft.	Quartzite with some schist.
West end, pioneer heading,	817 ft.	Slate with small quartzite bands.
West end, center heading,	654 ft.	Slate with small quartzite bands.

The west end pioneer heading footage is believed to be the American record of rock-tunnel progress. This heading was driven down grade through rock that could not be broken over 6 ft. per round. The best day's progress was 37 ft. Joseph Murphy is Assistant Superintendent at the east end, and Joseph Fowler is Assistant Superintendent at the west end; A. C. Dennis, Superintendent; Foley Bros., Welch & Stewart, contractors.

Grade-Crossing Elimination at Columbus, Ohio—Plans were approved on Dec. 4 for grade-crossing elimination on two miles of the line of the Norfolk & Western R.R., mostly within the city of Columbus. The work calls for 700,000 cu.yd. of embankments and the carrying of ten streets beneath the tracks, and is estimated to cost about $1,000,000. The ten streets will be spanned by steel structures on concrete piers. Under a state law, the railroad company will do all the work except paving the subgrade streets. The city will bear 35% of the cost of two-track work, but the company expects to provide for four tracks. J. E. Crawford, Roanoke, Va., is Chief Engineer of the Norfolk & Western, and Henry Maetzel is City Civil Engineer of Columbus. Grade crossings at Columbus have already been eliminated by the Baltimore & Southwestern, Hocking Valley, Toledo & Ohio Central, and the Little Miami Division of the Pennsylvania Lines. The city's share of the work already done has been about $1,000,000. There remain the grade crossings on the Big Four, plans for which may come along in 1915.

Electric Propulsion will be used for the battleship "California," contracts having been given by the U. S. Navy Department to the General Electric Co. for the installation of a complete drive similar to that which has proved successful on the collier "Jupiter." (See "Engineering News," Sept. 12, 1912.) It is reported that the guaranteed speed is 21 knots and the contract price $450,000. While details are not available, it is probable that there will be two high-speed steam-turbine alternating-current generating units and four induction motors, one on each propeller shaft. Presumably there will be two engine rooms, but then all four motors will be run from one turbine unit except at high speeds (above 15 to 19 knots). A new type of motor has been developed for this service, no starting or backing resistance being required as on the "Jupiter." This motor has a double squirrel-cage rotor, the outer layer of conductors having high resistance and the inner layer having low resistance. In starting or backing, the inner one takes very little current while the outer one gives high torque. Toward full speed, the inner cage comes more into action and ordinary induction-motor conditions prevail. The stators would have pole-changing windings to secure a further possible speed reduction between turbines and screws.

Contract Prices for Brick and Concrete Roads in Illinois—Contracts have been awarded during the current year for 74 sections of roads, having a total length of 481,888 ft., or 91.27 mi., of which 56 sections with a total length of 388,369 ft. or 73.56 mi. have been concrete and 18 sections with a total length of 93,519 ft. or 17.71 mi. have been brick. Almost 52 mi. of 10-ft. concrete roads have been contracted for at an average total price of $10,320 per mi., or $7250 for the pavement proper, which is at the rate of $1.23 per sq.yd. The minimum was $5960, and the maximum $9260 per mi., or $1.01 and $1.58 per sq.yd., respectively. The total price for the 18-ft. concrete roads has been $14,430 or $12,010 per mi. for the pavement proper, which is a little more expensive than the 10-ft. brick roads, which average $13,640 for a total cost, or $11,880 for the pavement alone. The average price for the whole 91.27 mi. (brick and concrete) is $12,240 per mi., of which $9420 is for the pavement proper. The unit price for 4-ft. macadam shoulders which average 5 in. in thickness is $1930 per mi. In nearly all cases where a long stretch of road is contracted for, the unit cost per mile is considerably smaller than where a short piece of road is built. This is due, in part, to the fact that the contractor can organize his force better on large work, which permits him to do better

and cheaper work, and, furthermore, he is willing to make a smaller percentage of profit on a large contract than on a small one.—K. N. Evans, Junior Engineer, Illinois State Highway Commission, in "Illinois Highways," November, 1914.

A Program for Earth-Road Maintenance is given by Frank S. Cook, Superintendent of Highways of Tazewell County, Ill., in the November issue of "Illinois Highways," as follows: "In the spring, as soon as the ground has settled sufficiently to get on the roads with a tractor, clean out the side ditches, using a 6- or 8-ft. grader and going two or three rounds, as may be necessary. Then follow up with the leveler, pulling the loose dirt into the hollow places and giving the road the proper crown. When this is done, I believe the heavy machinery should be put in a shed and left there. Road drags, under ordinary weather conditions, if timely used, will keep the road in good shape until winter, and even then they can be used to advantage. Getting the drags used systematically will be the hardest part of the work. The commissioners should make arrangements with the farmers along a certain road to drag at the same time when called up by the commissioner or by someone appointed to do so. Of course, the entire length of the road in the township should be dragged, for if parts of it are not, then some of the benefits of the dragging that is done will be lost. The work should be done after rains. If the road is not badly rutted, the dragging need not be done until the ground is partially dried out, but if the surface is uneven, then the work should be done while the ground is still wet so as to fill up the hollow places. Each one doing any dragging should be provided with blanks to be filled in and mailed to the commissioner immediately after doing the work. These slips should state the time, section of road, price per mile and the amount due for dragging on that date."

The Opening of the Magnolia Cutoff Line of the Baltimore & Ohio R.R. between Orleans Road and Little Cacapon, W. Va., a distance of 12 miles, on Dec. 6, marked the completion of the largest improvement of the kind ever undertaken. The line cost $6,000,000, or $500,000 per mile. The purpose of the new cutoff is to relieve the traffic congestion on the main line east of Cumberland, caused by the fact that two main lines from the West connect at this point. A third and fourth track were added to the main line, under a plan which eventually will provide a four-track railway to the seaboard at Baltimore. The cutoff is nearly straight and level, saves six miles in distance and 887° of curvature. The work entailed the excavation of 3,500,000 cu.yd. of rock and earth; building four double-track tunnels with a combined length of 7100 ft., erecting 25,000 cu.yd. of concrete bridgework, 50,000 cu.yd. of concrete retaining and inter-track walls, and removing 1,500,000 cu.yd. of material for a four-track cut 200 ft. deep, which takes the place of Doe Gulley Tunnel, where the four parallel tracks reach their highest elevation. Only 3000 tons of steelwork were used on the entire improvement. With the beginning of work 18 months ago, nearly 10,000 workmen and their families moved into the vicinity, locating chiefly in Paw Paw. A modern town was laid out by the railroad. The work was under the direction of Francis Lee Stewart, Chief Engineer, and John T. Wilson, District Engineer, of the B. & O. R.R. The contract was let in seven sections to as many contractors. The completion of the Magnolia Cutoff is the last item of a list of improvements involving the reduction of grades, elimination of curves, removal of tunnels, and purchase of new equipment, costing a total of $100,000,000.

PERSONALS

Mr. John Mitchell, City Manager of Hickory, N. C., has resigned and will reënter the practice of law at Walla Walla, Wash.

Naval Constructor David W. Taylor, U. S. N., has been appointed Chief of the Bureau of Construction and Repair of the United States Navy, succeeding the present Chief, Richard M. Watt, who retires Dec. 10.

Mr. Lazarus White, M. Am. Soc. C. E., recently Division Engineer of the Catskill Aqueduct, Board of Water Supply, New York City, is now Managing Engineer of Smith, Hauser & MacIsaac, Inc., Contractors, New York City.

Mr. William F. Robertson, City Manager of Sumter, S. C., resigned on Dec. 1 to become Secretary of the Chamber of Commerce of Greensboro, N. C. Sumter was temporarily without funds for improvements and Mr. Robertson, who is an engineer, wished a more active position.

Mr. W. F. Graves, Assoc. M. Am. Soc. C. E., Chief Engineer of the Montreal Tramways Co., has been selected as one of a committee of three to make a valuation of the track property of the Detroit United Rys. Co., for the Michigan Railroad Commission. He was formerly with the engineering staffs of the elevated and surface street railways of Chicago.

Mr. Byron T. Burt, F. Am. Inst. E. E., General Manager and Electrical Engineer of the Chattanooga & Tennessee River Power Co., Chattanooga, Tenn., has resigned to become Manager of the South American Trading Co., Buenos Aires, Argentina, which has recently entered the South American field for the sale of American manufactures. He is succeeded as General Manager of the Chattanooga & Tennessee River Power Co. by Mr. George S. Baker, former Auditor.

Mr. Sydney B. Williamson, M. Am. Soc. C. E., of J. G. White & Co., Ltd., London, England, has been appointed Chief of Construction of the United States Reclamation Service, a newly created office. Mr. Williamson is the well known Division Engineer of the Pacific division of the Panama Canal. Since the completion of Panama Canal he has been with J. G. White & Co., of London. He will spend the greater part of his time in the field, his particular function being to expedite construction work, and to secure the greatest possible efficiency.

Mr. Nicholas S. Hill, Jr., Consulting Engineer, New York City, announces that he has formed a partnership with Mr. Smith Farley Ferguson, former President of Mackenzie, Quarrier & Ferguson, Inc., Contracting and Construction Engineers, New York City, under the firm name of Nicholas S. Hill, Jr., & S. F. Ferguson, and with offices at 100 William St. Mr. Hill will continue as a consulting hydraulic and sanitary engineer, devoting his time entirely to work of a technical nature, while Mr. Ferguson will take charge of the office management and construction work.

Dr. John Edson Sweet, Past-President of the American Society of Mechanical Engineers, was awarded the John Fritz Medal of the national engineering societies at the annual meeting of the American Society of Mechanical Engineers, Dec. 2, for his work in the invention and development of the "straight-line" engine. He was born in 1832. His first work was as an apprentice to the carpenters' trade, and previous to the Civil War was engaged in building work in the South. Later he spent two years as a mechanical draftsman and student in England and Europe. In 1873 he was appointed Professor of practical mechanics at Cornell University, where he remained until 1879, when the Straight Line Engine Co. was formed.

Mr. Howard Whitney, a civil engineer of Nashua, N. H., has been appointed Engineer of Maintenance-of-way of the Springfield (Mass.) Street Ry. Co., to succeed Mr. H. M. Flanders, promoted as noted in our issue of last week. Mr. Whitney will have entire charge of the maintenance of track, bridges and structures of the street-railway systems owned or controlled by the New England Security & Investment Co., of which the Springfield Street Ry. is one. Mr. Whitney is a graduate of Tufts College, and his first engineering experience was with the Missouri Pacific Ry. Later he was Resident Engineer of the Grand Trunk Ry. at Woonsocket, R. I., and with the maintenance-of-way department of the Boston & Maine R.R.

Mr. F. H. Newell, M. Am. Soc. C. E., Director of the United States Reclamation Service, has been appointed Consulting Engineer of the Service, and the offices of Director and Chief Engineer have been consolidated, Mr. A. P. Davis, M. Am. Soc. C. E., the present Chief Engineer, becoming Director and Chief Engineer, as noted elsewhere. Mr. Newell is a native of Pennsylvania and a graduate of the Massachusetts Institute of Technology, class of 1885. He was engaged in the hydraulic work of the U. S. Geological Survey in 1888, and for 12 years, 1890 to 1902 was Hydrographer of the Survey. He was Chief Engineer of the Reclamation Service from its foundation in 1902 to 1907, when he was appointed Director.

Mr. Arthur P. Davis, M. Am. Soc. C. E., Chief Engineer of the United States Reclamation Service, has been made Director also, succeeding Mr. F. A. Newell, M. Am. Soc. C. E., who becomes Consulting Engineer, as noted elsewhere. Mr. Davis was born in Illinois in 1861 and graduated from the State Normal School at Emporia, Kan., and Columbian (now George Washington) University, Washington, D. C., in 1888, having won his degree while serving as a topographer in the U. S. Geological Survey. From 1895 to 1897 he was Hydrographer in charge of all government stream measurements, and from 1898 to 1901 Hydrographer of Isthmian Canal Commission, in charge of hydrographic surveys both at Panama and Nicaragua. He succeeded Mr. Newell as Chief Engineer of the Reclamation Service in 1907. Mr. Davis has also served as Consulting Engineer for the Isthmian Canal Commission, the Russian Government and for large irrigation projects in the American colonies.

OBITUARY

Taibaro Ueki, a civil engineer of Tokyo, Japan, died Oct. 30.

Cyrus J. West, a mechanical engineer, of Duluth, Minn., died Nov. 26 while on a hunting trip in northern Minnesota. He was born in 1850, and had lived in Duluth since 1884. From 1889 to 1892 he was Manager of the National Iron Works.

Samuel B. Christy, M. Am. Inst. M. E., Dean of the College of Mining of the University of California, a well known metallurgist, died Nov. 30, at his home in Oakland, Calif. He was 61 years old. He was a native of California and a graduate of the College of Mining of the University of California, class of 1874. He soon joined the faculty, and in 1879 was made Dean. He was known as an author, and was a member of many scientific and learned societies.

Lucius Tuttle, former President of the Boston & Maine R.R., died at his home in Brookline, Mass., Nov. 30. He was born in Hartford, Conn., in 1846, and after a public-school education, began his railway career as a ticket clerk on the Hartford, Providence & Fishkill R.R. Thereafter he was identified with the passenger departments of various early New England railroads until 1889, when he was made Commissioner of the Trunk Line Association. Subsequently he was General Manager of the New York, New Haven & Hartford R.R., and from 1893 to 1910, President of the Boston & Maine R.R., and its subsidiary, the Maine Central R.R.

Owen J. Travis, former Superintendent of Bridges and Buildings of the Colorado & Southern R.R. and the Fort Worth & Denver City Ry., died Nov. 14 at Everett, Wash., aged 66 years. His bridge-building experience began in 1868 with the Keystone Bridge Co. on the construction of a bridge in Kansas City, Mo. For several years he was Superintendent of Traffic of the St. Louis Bridge Co., and later Superintendent of Bridges and Buildings of the Middle division of the Wabash, St. Louis & Pacific R.R. He served in the same capacity with the Iowa Central R.R., the Elgin, Joliet & Eastern R.R., the Illinois Central R.R. and the Colorado & Southern R.R.

C. C. Mallard, Superintendent of the Arizona Eastern R.R., Globe, Ariz., died at New Orleans, La., Nov. 24. He was born in Georgia in 1860, and received his education at Stewart College in Tennessee. His first engineering experience was with the engineer corps of Morgan's Louisiana & Texas R.R. Later he was Assistant Engineer of the Sabine & East Texas Ry. and the Houston & Texas Central R.R., and Engineer for contractors on the Chicago, Texas & Mexican Ry. He returned to Morgan's Louisiana & Texas R.R. as Roadmaster and Assistant Engineer, and was promoted to be Assistant Superintendent of Bridges and Buildings of the Atlantic System of the Southern Pacific Co. From 1898 to 1905 he was successively Division Engineer and Assistant Superintendent of the Louisiana lines of the company. From 1905 to 1906 he was Assistant Engineer and Roadmaster of the Gila Valley, Globe & Northern Ry., and since 1906, Superintendent of this road and its successor, the Arizona Eastern R.R.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN ROAD BUILDERS' ASSOCIATION.
Dec. 14-18. Convention at Chicago, Ill. Secy., E. L. Powers, 150 Nassau St., New York City.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.
Dec. 28-30. Annual meeting at Chicago, Ill. Secy., F. M. White, Madison, Wis.

SOCIETY OF CONSTRUCTORS OF FEDERAL BUILDINGS.
Jan. 4-6. Convention at Washington, D. C. Secy., T. R. Maul, 4213 Westminster Ave., Philadelphia, Penn.

ASSOCIATION OF GOVERNMENT CONTRACTORS.
Jan. 4-7. Annual meeting at Washington, D. C. Secy., Algernon Blair, Montgomery, Ala.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.
Jan. 15. Annual meeting at New York City. Secy., J. R. Wemlinger, 11 Broadway, New York City.

AMERICAN WOOD PRESERVERS' ASSOCIATION.
Jan. 19-21. Convention at Chicago, Ill. Secy., F. J. Angier, Mt. Royal Station, B. & O. R.R., Baltimore, Md.

AMERICAN SOCIETY OF HEATING & VENTILATING ENGINEERS.
Jan. 20-22. Annual meeting at New York City. Secy., J. J. Blackmore, 29 W. 39th St., New York City.

AMERICAN CONCRETE INSTITUTE.
Feb. 9-12. Convention at Chicago, Ill. Secy., E. E. Krauss, Harrison Bldg., Philadelphia, Penn.

Brooklyn Engineers' Club—The annual meeting of the Brooklyn Engineers' Club will be held at 117 Remsen St. on the evening of Dec. 10. The nominations for officers for the ensuing year are as follows: President, J. S. Langthorn; Vice-President, G. Laurence Knight; Secretary, Joseph Strachan; Treasurer, William W. Brush; Directors, Carleton A. Graves and Percy C. Barney. The annual dinner will be held at the Club on Dec. 17.

Engineers' Society of Pennsylvania—The following candidates have been nominated for office during the year 1915: President, Farley Gannett, Engineer Water-Supply Commission of Pennsylvania, Harrisburg; First Vice-President, Charles H. Mercer, Chief Engineer of Bridge and Construction Department, Pennsylvania Steel Co., Harrisburg; Secretary, Edward R. Dasher, Harrisburg; Treasurer, R. Boone Abbott, Division Engineer, Philadelphia & Reading Ry. Co., Harrisburg. The election will be held at the headquarters of the Society in Harrisburg on Friday evening, Dec. 11, 1914.

Engineers' Club of Philadelphia—The "Bulletin" of the Club for November announces a plan for the unification of all the engineering societies of Philadelphia, with the Engineers' Club as a nucleus. The Executive Committee proposes to change the name of the organization to the Engineers' Society of Philadelphia, and to establish four classes of members, active, junior, honorary, and affiliated. The last class would include all members belonging to affiliated societies. All these societies would have the advantage of the use of the present house of the Engineers' Club, and their members would be eligible for active membership in the Club.

Granite Paving Block Manufacturers' Association of the United States—A number of Eastern granite paving block manufacturers met in Boston, Dec. 3, and organized for the following purpose:

Whereas, It is desirable that the high value of granite paving blocks for use in the building and constructing of streets and roadways be made known to the general public, and that the manufacture of the same be made to conform to a high and proper standard, and that the use of the same be adapted to other purposes, all to the end that the manufacture and use of said granite paving blocks may be stimulated and increased for the mutual benefit of the public and manufacturers of said blocks, therefore, the subscribers hereto form an association to be known by the name and style of "Granite Paving Block Manufacturers' Association of the United States," in order to promote the welfare of its membership in such manner as this constitution and these by-laws provide.

The following board of directors was unanimously elected: C. Harry Rogers, of the Rockport Granite Co., of Boston, Mass., President; Joseph Leopold, of J. Leopold & Co., Inc., of New York, Vice-President; James Adamson, of Booth Bros. & Hurricane Isle Granite Co., of New York, Secretary; Thomas Lahey, of the Hildreth Granite Co., of Boston, Mass., Treasurer.

New York Section of the American Water Works Association—The third meeting of this local branch of the society was held in the banquet room of the Manhattan Hotel, Dec. 3. After the usual luncheon, two papers were read. The first, by W. W. Brush, Deputy Chief Engineer of the Department of Water Supply, Gas and Electricity, New York City, described the work, equipment and organization of the maintenance division of the department. The paper was interesting and unusual and was illustrated by many lantern slides. The distribution system was described from the point where the water leaves the city reservoirs or the new tunnel of the Catskill aqueduct to the street mains, many of which are in very complicated situations, due to the multitude of other subsurface structures. Various yards and equipment were illustrated, not, however, as models of perfection; indeed, one wonders how the department is able to do such efficient work as the mere maintenance of hundred of miles of main requires, with such insufficient facilities. The division of the city into repair zones and the organization of the force of about 750 employees into maintenance and repair companies was of interest chiefly from the magnitude of the work to be done. The standards of practice in eliminating as many sizes of valves as possible, in systematic search for leaks and in other points were outlined, but these and many more details are to be given in a more formal paper to be presented later to the parent society. The second paper by Daniel F. Fulton, City Engineer of Yonkers, N. Y., gave a history and descriptive outline of the Yonkers water-supply, and the proposed development to serve a city of 200,000. The problem of Yonkers is interesting because, like other small cities which have the misfortune to be suburbs of great cities like New York, all its really economical water-supply resources have been gobbled up for metropolitan use. Hence, Yonkers is practically shut out from a new supply and is obliged to further develop its present sources to their fullest capacities.